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Andrew Kende and Barbara Wolff, winners of the Westinghouse Grand Science Scholarships in 1948. (See page 70). Credit: Acme

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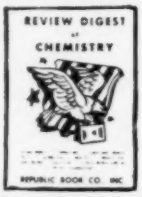

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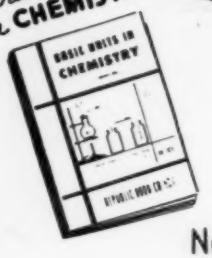

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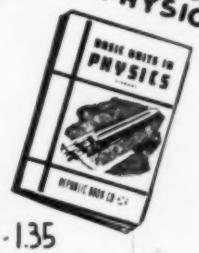

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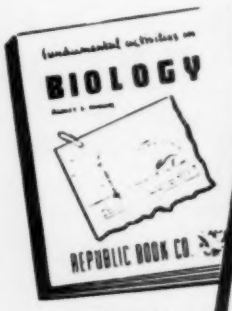

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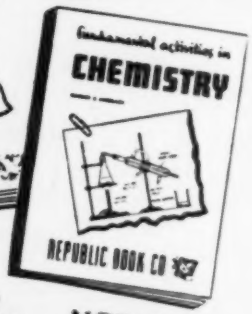

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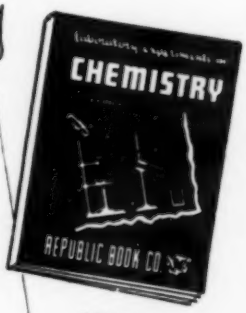

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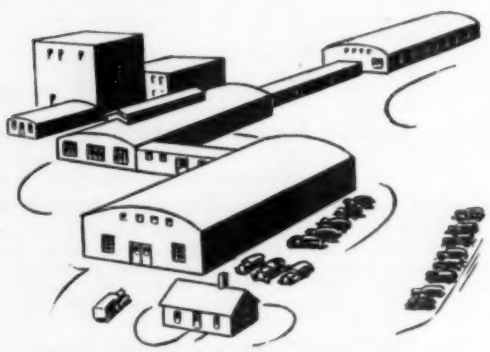

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VOLUME XV APRIL, 1948 NUMBER 2

The Effectiveness of Science Teaching

A Forum by the AAAS Co-operative Committee on the Teaching of Science and Mathematics

PART II

(Part I of this Forum was printed in the February issue)

The Effectiveness of Our Schools in the Teaching of the Biological Sciences[1]

GLEN W. BLAYDES

Department of Botany
The Ohio State University

L. V. DOMM

Whitman Laboratory of Experimental Zoology, The University of Chicago

THE BIOLOGICAL sciences bear a tremendous responsibility in solving numerous crises which human society is now facing. In biological education we must contrive more adequate training for our people in order to solve many of these impending problems.

Of all the land areas in the world only about 11 per cent of 4,000,000,000 acres are suitable for food and fiber production. There are about 2,000,000,000 human beings living in the world today. They must get their foods and fibers from this area. This means that there are available to each person only two acres[2], or about twelve average city lots upon which his foods and fibers may be produced. In Ohio[3], records for the average annual yields of the cereal crops extend over a period of almost a century. The average annual yields of these crops today are about what they were 100 years ago. During this period improvements have been made in crop plant varieties, methods of tillage, use of fertilizer, crop rotations, and the invention of agricultural machines, which should have increased yields, according to conservative estimates, from 40 to 60 per cent. These advances, as great as they may be, have not been more than sufficient to maintain the yields of a century ago. The destructive forces of accelerated erosion and depletion of soil minerals and humus content are equaling the advances that man has made. These destructive forces are winning slowly, but with a dreadful certainty. Not only are your two acres and mine, producing less and less, but with an increase in population we must divide some of our food with others. These facts are well known, yet when a study was made in 1942 of the biology courses in the secondary schools of the United States[4], only 11 per cent indicated that some emphasis was placed upon the subject of conservation! Many of the more important facts and principles of biology have direct application to the problems of conservation. In fact our only hope that the yields of food may be

1 Contribution from the Department of Botany, The Ohio State University, paper No. 507, and from the Whitman Laboratory of Experimental Zoology, The University of Chicago.

2 Eisenhower, Milton S. Two acres for your life. Collier's 119 (19): 80. 1947. Variation in such estimates occur from about 8 acres to each person, as given by Pearl, Raymond. War and Overpopulation. Current Hist. 43: 589-594. 1936, to about 1 acre by Pearson, Frank A. and Paarlberg, Don. Starvation Truths, Half-Truths, Untruths. N. Y. State College of Agriculture, Cornell University, Ithaca, N. Y. 1946.

3 R. M. Salter, R. D. Lewis, and J. A. Slipher. Our Heritage—the Soil. Bulletin 175, Agricultural Extension Service, The Ohio State University.

maintained and increased are dependent upon the spread of these facts and principles and their applications to the soil and the organisms growing on it.

IN THE SAME survey only 13 out of 1,086 replies claimed some attention given to the process of photosynthesis. This process is surely one of the most fundamental in all biology. It is a process occurring in green plants by which light energy is converted into chemical or stored energy. Sugars are made and contains this energy. This energy runs the biological world and most of the industries of man. Also, sugars become the chief "building blocks" from which all other foods and biological substances are made. In addition to the sugar made by this process, oxygen is released. This is the fundamental source of oxygen which maintains a fairly constant concentration in the atmosphere about us. It is being steadily used by most organisms in the process of respiration. An average high school boy or girl, with a few potted green plants, and a balanced aquarium can demonstrate effectively the process of photosynthesis. By a few careful observations is is readily determined that the environment of the plant is important in the process—that light, carbon dioxide and water are necessary, any one of which may limit the process—that the process does not occur in non-green tissues and hence the importance of the green pigment chlorophyll. Here we have all the elements of a good experiment concerning a biological process, factors of the environment, conditions within the organism, sugar that is made and the oxygen released in the reaction. With a minimum of directions from the instructor, the student is able through his own observations to discover the fundamentals of this important biological process. He does not have to get his answers from the teacher, or a textbook—he discovers them himself! When confronted with the question of why grass is not growing in a densely shaded area under a tree just outside the laboratory window he is not long in coming up with the answer—that any plant starting to grow there dies of starvation since it cannot make sugar in the dense shade. We have here, a demonstration of the scientific method of approach and a cause and effect type of explanation. The teacher then looks up at the electric lights in the laboratory, he moves over to the light switch, snaps it off and on again. He asks the student of photosynthesis to trace the origin of the electric energy observed in the electric light. Soon, he is able to trace it to the dynamo, steam turns the dynamo and the energy of steam comes from the burning coal under the boilers the coal is plant material which lived some 300,000,000 years ago, storing energy from sunlight in the process of photosynthesis—energy which we can command today by turning a switch! About 89 per cent of the biology teachers in high school are missing an opportunity to teach more effectively when they fail to include photosynthesis in their biology courses.

ANOTHER relatively unpopular subject and one of a controversial nature, which was studied in the survey of biology courses[5] of some five years ago, is that of evolution. This principle permeates the whole of biological sciences. For the well trained biologist it is fundamental, it is inescapable! Yet less than 50 per cent of the high schools of the United States include this subject in their biology teaching. If anything, it is an educational liberator—a liberator from dogma passed down from the dark ages, by those with absolute ignorance of this biological phenomenon, and forced through fear upon more than 50 per cent of our high school population. About 90 per cent of those in high school will never have a chance at another point of view. A good observer does not have to look far until he finds cases of heritable changes taking place in plants and animals including man. All that is meant by evolution is that heritable changes may occur. Mutations, hybridization and hybrid segregations are the bases by which all of our domesticated plant and animal varieties have made their appearance. Consider all of the varieties of wheat, potatoes, corn, tomatoes, dahlia, gladiolus, iris, apples, peaches, cherries, swine, cattle, dogs, cats, chickens, rabbits, etc., and you have an astounding array of evolutionary evidence

4 Riddle, Oscar, Fitzpatrick, F. L., Glass, H. B., Gruenberg, B. C., Miller, D. F. and Sinnott, E. W. The Teaching of Biology in Secondary Schools of the United States: The Committee on the Teaching of Biology of the Union of American Biological Societies. 1942.

5 Riddle *et al.* 1942.

Continued on Page 82

Mathematics—Grades One to Twelve

RALEIGH SCHORLING

School of Education,
University of Michigan

THERE is nothing wrong with the teaching of mathematics in grades 1 to 12 that a gifted teacher in every classroom could not correct. How to get a competent and zealous teacher in every classroom is, and always has been, the nation's number one educational problem.

The ceiling as regards what teachers can achieve under present conditions is low. But we must do what we can. To that end, it is important that we see clearly our main problem. The recent report[1] of the Cooperative Committee on the Teaching of Science and Mathematics lists a considerable number of limitations or weaknesses in our teaching of mathematics in grades 1 to 12. All of them, it seems, can be classified under three major problems:

(1) the meaningful teaching of symbols, concepts, and principles,
(2) the identification of the specific mathematics that needs to be included in general education, and
(3) the proper culture of youth who have special talent in mathematics.

I. AN EMPHASIS ON MEANINGS

A FUNDAMENTAL weakness in the teaching of arithmetic is that many pupils do not understand what they are doing. This is often true even when they understand the mechanics of the solution and get the right answers. Then too, pupils turn in fantastic answers without even realizing that their contents are absurd. *There isn't sufficient emphasis on meanings.* Pupils may be required to memorize tables involving pints, quarts, and gallons, or inches, feet, and yards, without meaningful or sufficient experience with the actual objects used in measuring. The tendency to force symbolism and drill upon children too early is very pronounced. The pedagogical principle that understanding of words, symbols, and principles stems from experience should be applied in the teaching of most of the concepts commonly included in arithmetic courses.

In formal instruction we often put the cart before the horse. Here is a common routine: (*a*) A school system administers a standardized arithmetic test. (*b*) It discovers that the control of the fundamentals in arithmetic is shockingly low. (*c*) It goes into an all-out program of drill workbooks. In all probability the pupils have had plenty of drill of the wrong kind and are now given larger doses of a medicine that heretofore has not taken effect.

II. MATHEMATICS IN GENERAL EDUCATION

IN RECENT years, universities and colleges have given a good deal of attention to general education. The high school, since the turn of the century, has had the dual responsibility of providing (*a*) rigorous training for leadership in science, mathematics, and other learned fields, and (*b*) good general education for better living and for use in the common affairs of life. It may be that the college people are not talking about the same thing as the high school people when they discuss general mathematics. It may be that we need two definitions for general education—one as an essential for citizenship, and the other appropriate for the well-educated person. Be that as it may, we will not get anywhere in our high school program of general education until somebody defines what it is in a way that is commonly acceptable. Here it is gratifying to know that a first step has been taken in the Second Report of the Commission on Post-War Plans of the National Council of Teachers of Mathematics.[2] The report identifies 29 specific concepts and principles in mathematics that are considered essential in the education of all citizens.

III. THE CULTURE OF TALENT

A SOUND educational program for youths with special talent in mathematics would no doubt be equally desirable for students gifted in other fields, such as art, music, in-

1. *Manpower for Research*, Volume Four of Science and Public Policy.
A Report to the President, by the President's Scientific Research Board. Washington: Government Printing Office, 1947.

2. "The Second Report of the Commission on Post-War Plans," The *Mathematics Teacher*, May, 1944, pp. 226-32.

vention, statesmanship, and creative writing. Under the present conditions in our schools, it is highly probable that many youngsters with special talents are lost, or at any rate that they do not develop as well as they should. We cannot be confident that the typical teacher of the early grades with little or no training in mathematics and science can spot a youngster with talent in these areas or that she would be able to design appropriate experiences that would fan the spark of genius. Then, too, many of the senior high school courses do not now provide sufficient challenge and certainly not enough practice in the scientific method for talented youth.

A good program for gifted youth, whether it be in mathematics, art, or any other field, would seem to involve (1) early identification, (2) reliable guidance, and (3) an appropriate curriculum for the individual student.

1. Early Identification

THERE is good reason to believe that the beginning of the ninth school year is the time for differentiation of courses and classification of students. The future scientist is almost certain, by that time, to want more organization, more rigor, and more continuity, than can be or should be provided in the general courses. In the ninth grade we should operate a double track—at least in mathematics.

In sectioning students, schools should abandon the undesirable practice of attempting to get homogeneous groups by classifying pupils on the basis of intelligence tests alone, for that policy inevitably stigmatizes the general mathematics courses. Other things that should be taken into account are reading, computation, and general achievement in the earlier grades. Then too, some schools seem to find it helpful to use algebra aptitude tests.[3] The best single criterion obviously, for selecting a pupil for the algebra class, is the desire and the abilit to do algebra of a high order of excellence.

2. Reliable Guidance

HIGH SCHOOL teachers in general do not provide their students with reliable information about the science and mathematics needed on jobs and in professional careers, for two reasons: (*a*) the teachers lack knowledge of the applications of science and mathematics made in engineering, agriculture, mining, medicine, and the like, and (*b*) they do not have the necessary guidance materials.

The first guidance material geared to a high school subject was published in the November, 1947 issue of the *Mathematics Teacher*. The purpose is to describe for high school pupils some of the occupations in which mathematics is important. The student learns about the amount and kind of mathematics that is used and the school level at which it should be taken. Reprints should prove very useful to guidance personnel, in classifying students at the ninth-grade level. Here teachers of mathematics can find information that they can give to pupils and parents in a long time program of guidance prior to the ninth grade.

3. An Appropriate Curriculum

THE TEACHING profession has not shown great resourcefulness or utilized much imagination in the design of curricula appropriate to the nurture of genius. Presumably this is a difficult task for the curriculum builder in any field. For thirty years, at least, pedagogical journals have given much space to the problem of adjusting to individual differences. In a very real sense a good high school has to provide a curriculum for each individual child. This, of course, does not imply that youth of talent will not move in classes. In the small schools they would no doubt be in non-homogeneous groups. Nevertheless, special provision should be made—if not by especially designed courses, at least by appropriate assignments, by challenging projects, and by bits of research that take the pupil out of competition with his less able fellow students. Such glimpses at the achievements of creative workers in his field of special interest and at the steep road ahead of him will keep him humble and fire his imagination. Probably the crux of the matter is the competent and inspiring teacher with a small class. At any rate, the unusual showing made by certain small colleges in the development of outstanding scientists needs to be explained.

To what extent especially designed courses

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3. Herschel E. Grime, "Aptitude and Ability in Elementary Algebra," *School Science and Mathematics*, December, 1947, pp. 781-784.

Science Teaching Today*

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Purdue University

YOU HAVE HEARD why a survey of the present status of Science teaching was necessary. The number of scientists in the nation is small; only around 137,000 can be classified as productive scientists. The training of these scientists on an advanced level is limited to a small fraction of our Colleges and Universities; some 50 institutions are responsible for 95% of all the Ph.D's in this country. The present influx of Veterans into our Colleges tends to crowd many into so called Name institutions without full use of staff and facilities in smaller institutions. The increasing opportunities in Industrial and Government research laboratories has taken its toll of College and University faculties and the increasing student-teacher rates threatens everywhere seriously the efficiency of teaching, particularly of the natural sciences. Therefore, the problems of Science teaching presented today show that we have to consider first all the recruiting and training of teachers at all levels. To the estimates mentioned today we may add that the President's Commission for higher education foresees that between 1950 and 1960 one million new teachers will have to be recruited and trained.** Where are the science teachers going to come from if only 1% of our college population is in practice teaching, and if only .13% are practice teaching in science and mathematics? Of all the people planning to go to college, less than 1% want to become college and university teachers, and all this with ever-increasing enrollment in the schools and universities, and obviously without teachers, there will be no adequate preparation of students and no scientists to take up the work of the older generation.

BUT TO remedy this situation and to bring Science to the citizens, we must start early; the deep curiosity of the child might be kept stimulated throughout the course of education, and for this purpose we have to consider the problem from the elementary, through the secondary, to the advanced type of education.

The science curriculm in the schools has to be considered as an integrated program from the 1-12 grade. Every effort must be made to introduce systematically the concepts and ideas of Science which the *average* citizen needs to understand. On the other hand, it is essential to select and identify at an early age the specially gifted, and use all guidance and selection techniques to ascertain that these students will have the full opportunity to develop their talents while they are still in the schools.

The most difficult part of the science programs in the schools is usually the integration with mathematical concepts. These mathematical concepts introduced in the elementary schools in the form of arithmetic and elementary geometry are usually divorced from applications in the work actually being done at the same time in the sciences. But it is essential that we provide a background in the elementary techniques of mathematics both for the student, who will go on to college, as well as for the citizen who will receive the last formal education in high school. For this purpose, the double track method is recommended which means courses in general mathematics, which should prepare the citizen with a better understanding of quantitative formulations, and on the other hand the elements of algebra and geometry have to be taught to prepare the students for college.

UNFORTUNATELY, science is still not a general prerequisite for college entrance and it is possible for a student to go through high school and college and remain scientifically illiterate, at least in so far as the physical sciences are concerned. This is true in spite of the fact that a great many of the applications of science and their implications are now discussed widely and effectively by the public press, but in academic education, up-to-date information which the student demands is usually lacking because we do not have enough source material from which the

*A Summary of the report of the Cooperative Committee on "The Effectiveness of Science Teaching."

**"Higher Education for American Democracy." Volume I "Establishing the Goals." A Report of the President's Commission on Higher Education, December, 1947, p. 77.

teacher can draw with full understanding of the scientific and cultural backgrounds.

This becomes painfully clear in the physical sciences. It is shocking to hear that in this age of atomic energy, only about 7 per cent of our total high school population are exposed to physics or chemistry. It is still more shocking to realize that a student can go through college, and even become a teacher of science, with not more than possibly one science course in the field in which he wants to specialize, and hardly any understanding of the physical basis of science.

The physical sciences present a unique problem to the teacher because they require that there is a constant check of theoretical and speculative predictions by experiment and that the planned experiment must be *described by a proper translation into symbolic language.*

Interest in the physical sciences suffers a great deal because their relation to the neighboring sciences, such as biology, astronomy, and geology is not enough emphasized, either on the high school or at the college level. As a consequence, the students coming to the colleges are prejudiced against the physical sciences and, as has been pointed out, the duty of the scientist himself is to see to it that the importance of the physical sciences as the basis for medicine, biology, and agriculture, as well as the basis for engineering development are stressed in such a way that practical applications become evident.

BUT PHYSICS is also natural philosophy, and this philosophical aspect, the development of ideas and concepts through science, has to be emphasized not only to avoid the training of only scientific technicians, the broad aspects of the sciences and their interrelation are of particular importance.

The tremendous responsibility of the biologists becomes clear, because for the great majority of our school population, a course in biology is the only contact with science. Therefore, "the tactics and strategy of science," to use Contant's phraseology, must be brought to the attention of the large number of students in the biological sciences.

The social implications of the biological sciences have been stressed by pointing out the necessity of understanding that one of the most important bio-chemical reactions known in nature, is the action of light on the plants or photosynthesis which is the basis of our energy sources The understanding of human physiology, gentics, and sex education are all responsibilities of the biologists. It is shocking to learn that not all of our schools prepared to teach this subject teach• evolution, that only some of the teachers have a sound knowledge of the subject and are prepared to teach it.

IN VEIW OF ALL the facts which we have gathered, the Committee made recommendations to increase the effectiveness of science teaching, as follows: We must act *at once* to alleviate the present crisis in Science teaching:

(1) Steps must be taken to provide improved working conditions in a high percentage of our school systems, otherwise, it will be impossible to attract and keep an adequate number of science teachers at all levels of science instruction.

It is necessary that every effort be made by the Communities, the States, and the Federal Government to adjust teacher's salaries to present economic conditions. Legislation relating to financial support of vocational and technical education must be amended and future legislation be formulated to include provisions for the teaching of the basic sciences and mathematics.

(2) Every national scientific organization should make a special effort to make the public aware of the facts regarding teacher shortages.

(3) Institutions engaged in the education of teachers for elementary and secondary schools should provide stronger programs. They need to:

a. Design a curriculum that is appropriate for such teachers.
b. Provide training in broad areas rather than specialization in one field.

(4) Higher institutions, as well as public school systems, should provide strong in-service programs for teachers. It is as badly needed in the typical college and university as in the senior high school.

(5) Local, State, and Federal full subsistence *scholarships* should be established for

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President's Page — By Morris Meister

Professional Standards

THE NSTA Platform for Action has focussed a spotlight on a number of essential problems in science teaching. Through articles, conferences, discussions and studies, attention has been drawn to these problems and to possible solutions. While unanimity of opinion can be rarely obtained, areas of agreement can be ever widened. It is important that science teachers everywhere and at all levels know about these areas of agreement and their extent and have an opportunity to react to them.

As an example, let us consider the matter of Science Rooms—their physical arrangements and facilities. What should they be like, if good science teaching is to be carried on in them? Who decides how many science rooms there shall be in a new school building? What facilities shall be made available? To what extent and how shall we provide for demonstration teaching, for individualized laboratory work, for storage of equipment, for pupil projects, for science clubs, etc.? What *Standards* are there, other than those of the Budget, the Architect, the Fire Department and the administrative convenience of lay Boards of Education and non-science trained school administrators?

HAS NOT THE time arrived when science teachers can speak clearly and emphatically on this subject? What we propose, then, is that NSTA, together with other professional organizations of science teachers, offer a set of Guiding Principles with respect to Science Rooms. Let us start with the secondary schools, where the problem is critical. Let us put down in writing what we believe. After widespread discussion, let us modify and refine that statement, adding further implementation, if necessary. Then let us publish and spread widely the best thought on the problem. We are confident that architects, school superintendents and educators generally, will welcome these Guiding Principles and the Standards that grow out of them. The science teacher will gain new assurance and support in his efforts to do good science teaching. The "Standards" will provide an anchor and a frame of reference. We will not, as has happened so often in the past, lose by default.

May we urge our membership to read the proposed "Standard" on Science Rooms (See page ..... in this issue) and to give us their reactions. After committee conferences and discussion, a revision can be again presented. When reasonably satisfactory, the "Standard" can be given wide publicity. If this procedure proves useful, we can consider similar "Standards" with respect to other planks in our Platform for Action.

YOU CAN HELP THE PACKET SERVICE

BOTH SCIENCE teachers and Industry are enthusiastic about the NSTA Packets of Science Information for Teachers. Nearly fifty pieces of commercial literature have been carefully evaluated and distributed to our membership. Additional Packets are in process of preparation.

However, Industry will not continue to supply this expensive service to science teachers indefinitely, unless science teachers indicate that they find the service useful. Hence it is essential that you and your pupils write to the companies. Tell them why you like their materials, or why you do not. Tell them how you are using the materials, or why you can not. Tell them about your teaching needs and the kind of literature you would be glad to use if it could be made available.

Even a penny post card reaction will be welcome. If you have the time, write us, too. Our Director of Membership Service will be glad "to carry the ball" for you.

But, write you should—if our fine Packet Service is to continue to grow and to improve its contributions to good science teaching.

Simplicity in Demonstrating Physics

(Concluded from February issue)

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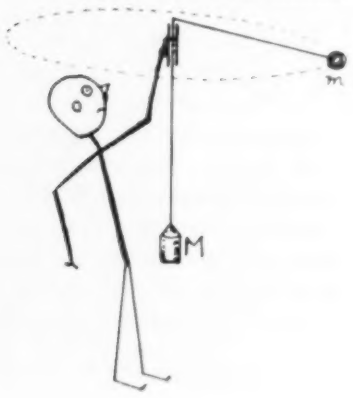
HERE IS A simple experiment on circular motion and centripetal force. You see here a 35-gram rubber ball tied to a string about one meter long. The string passes through a short glass tube and its other end is attached to a 1000-gram weight. If I lift the tube, the ball rises because it is not nearly heavy enough to raise the 1000-gram weight which remains on the table. But if I swing the ball in a circle, you see that I can make it lift the weight (Figure 1.) The ball is evidently being pulled toward the center of its orbit by a force of 1000-grams, almost 30 times its own weight! We call this force acting on the ball the *centripetal force*, in this case, 1000 grams. There is an equal and opposite force acting on the weight, the centrifugal force. If the rubber ball swings in a large circle, you see that it does not have to revolve as many times per minute as when the ball swings in a small circle. By actual test against stop watch timing, it is possible to demonstrate the laws of centripetal force quantitatively. The product of the radius of revolution and the square of the number of r.p.m. is constant for a given weight acting to accelerate the ball toward the center. It is impressive to consider that the ball, in this case, is being accelerated toward the center of its orbit at about 30 times the acceleration of gravity, or at more than 900 feet per second per second!

Fig. 1. A swinging ball lifts a weight and thereby demonstrates centripetal force.
Credit: The Science Counselor.



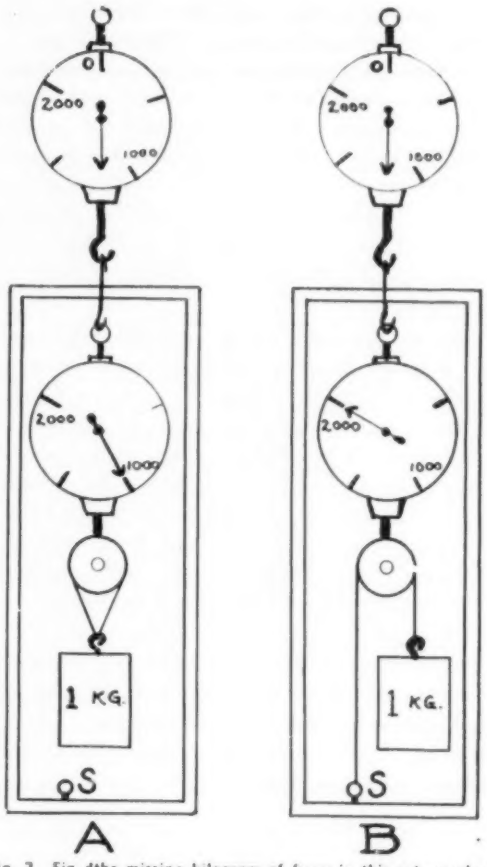


Fig. 2. Fin dthe missing kilogram of force in this set-up when the weight is hung from the pulley.
Credit: The American Physics Teacher.

Moral: "Make the experiment at least as simple as the concept to be illustrated." Here everything is in sight. Various aspects of the forces involved are clearly evident in simple and striking fashion. The weight at the center and the radius of revolution of the ball may both be varied and the laws of circular motion explored.

SIR ISAAC NEWTON came to the conclusion that the earth must be flattened at its poles because of its rotation, and he even calculated the ratio of polar to equatorial diameters. Here is a large rubber ball with

a map of the earth painted on it. I can rotate it by means of this small motor held in my hand. As its speed of revolution increases, you see it begin to flatten at the poles and bulge at the equator. At high speed, the deformation is very pronounced. Our own earth may be in pretty bad shape these days, but nothing like this ball. If we had sunrise every 1½ hours instead of every 24, the oblateness of our own earth would be much greater and objects at the equator would have "no weight." That is, the whole gravitational attraction of the earth would be needed just to keep objects moving in their circular paths of about 4,000 miles radius, once every hour-and-a-half, and there would be "nothing left over" to make bodies have weight.

Moral: "Show experiments that point up principles in exaggerated form." Follow the laws of physics out to extremes.

HERE IS A mechanical puzzler consisting of two simple dial spring balances. The upper balance supports the lower balance and the wooden frame. Both balances read zero, but if I hang a kilogram weight on the lower, both balances read 1000 grams (Fig. 2). If, however, I hang the weight from this pulley on the lower balance, so that the supporting cord is attached to the bottom of the light wooden frame, then what will each balance read? Will they both be the same as before, or will either one be different? A class usually concludes that the upper one will read the same, but there is no agreement on the probable reading of the lower one; it might read the same, half as much, or twice as much. Cover up the balance and let the class vote. Then show the result. The lower balance reads *twice* what it did before! But how can it read 2 kilograms when the upper one reads only 1 kilogram? Look for that missing kilogram of force and you will find it acting upward at the supporting hook on the frame.

Moral: "When students have reached intellectual complacency, stump them with teasers." An experiment like this is good to show *after* principles have been well discussed. Few students will guess the right answer.

LET US TURN to three or four experiments on vapor pressure. Water vapor in the air has an important bearing on the weather. First, let us make a cloud in this large flask. The flask contains a little water and the space within it is saturated with water vapor. If a little smoke from a burning match is admitted, it provides ions and other nuclei upon which water vapor can condense, but condensation does not occur. However, if the whole volume can be suddenly cooled, a fog should form. That may be made to happen by suddenly reducing the pressure. The air expands adiabatically and there is not time for exchange of heat to take place. The temperature falls well below the dewpoint and fog particles form in great numbers. This expansion may be brought about in several ways. A vacuum pump is the most certain and easiest. Cloud after cloud may be formed by raising and lowering the pressure. Each time air is admitted at atmospheric pressure, the cloud suddenly disappears, but reappears whenever the pump reduces the pressure again. The demonstrator can bring about the same effect by sucking air from the flask with his lungs. Finally, if a little alcohol or ether is poured in and the flask quickly stoppered and allowed to come to thermal equilibrium again, a cloud is formed the instant the stopper is removed. This method cannot be repeated as the earlier two can because it depends upon raising the pressure within the flask by the partial pressure of alcohol or

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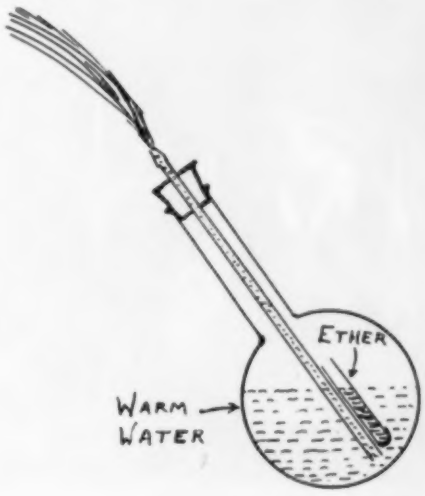
Fig. 3. A vapor pressure fountain produced by boiling ether.



Gay-Lussac's Law and the Absolute Zero

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THE RELATION of the absolute pressure of a gas to its absolute temperature is here considered as Gay Lussac's Law. The apparatus consists, mainly, of a 1000 cc. flask and a closed manometer. The closed manometer is made from a glass tube 19 inches long with a 4 mm. interior bore. The closed arm is 13 inches long and the open arm 6 inches. A 7/8 gallon fruit can may be used in place of the battery jar.

The jar is partly filled with the coldest water obtainable from the cold water tap. After the flask has been immersed in the cold water for a time, the air within is at the temperature of the cold water and under one atmosphere of pressure. The pressure in pounds per square inch is computed from the barometer reading.

To obtain a second set of readings of temperature and pressure, the length of the air column in the manometer is determined. The manometer is then connected to the flask while it is still in the cold water.

Raise the flask above the jar and change the water. (Water of about 50 degrees higher temperature should be used.) Lower the flask into the hot water and again read the thermometer and the length of the air column in the manometer.

The change in volume of a gas may be determined by means of a manometer connected to a flask warmed with water.

From the first and the second readings of the manometer, compute the pressure of the air at the higher temperature. Obtain the ratio of the first and second absolute temperatures and the ratio of the first and second absolute pressures. (Pressure determined by a closed manometer is the absolute pressure.) From these two ratios the relation can be discovered and expressed as a law.

AN INTERESTING application of the experiment is to assume the truth of the law and substitute the data obtained from the experiment in the relation or formula and determine the location of the absolute zero on the centigrade scale. From the law the following formula or equation can be stated:

$$\frac{\text{Second pressure (absolute)}}{\text{First pressure (absolute)}} = \frac{X + \text{Second centigrade reading}}{X + \text{First centigrade reading}}$$

X here stands for the number of degrees the absolute zero is below the zero on the centigrade scale.

For detailed instructions to students for working this experiment and thirty-six other experiments that are new in laboratory work, write to the author for a copy of Experiential Physics.* These instructions are so written that the student can be held responsible for the entire task without any previous class room discussion.

It is the author's contention that, whenever possible, a law or principle should be discovered by a student through his own individual demonstration or performance in the laboratory. It is an accepted theory of education that the instructive value of a student activity is largely in proportion to the amount of initiative required on the part of the student.

IN THE December number of *The Science Teacher*, Mr. Hellman takes exception to

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Audio-Visual Aids

EDITED BY CHARLES R. CRAKES

The editor of this department will attempt to bring before the readers of this publication the latest articles written by science teachers who are making effective use of various forms of audio-visual teaching materials. He will also endeavor to present a cross-section of educational opinions on audio-visual aids he may gather in travelling about North America.

Mr. Harold B. McCreight, the author of our current article entitled "Audio-Visual Aids in Physics," is particularly interested in making more effective use of audio-visual teaching materials on the high school level. His article can well form a basis for group discussion on the more effective utilization of projected teaching materials within the actual classroom teaching situation.

His article has been set up in sequential order and quite clearly illustrates the four steps in good techniques of utilization, namely

1. Teacher preparation.
2. Pre-showing discussion period or the preparation of the class.
3. Showing of the materials under the best physical conditions.
4. Post-showing discussion period.

Mr. McCreight is now serving as mathematics and science instructor at the Chaffey Union High School, Ontario, California. Before this assignment Mr. McCreight has had many years of experience as science instructor in the high schools of Visalia, California; Ely, Nevada; and Broken Bow, Nebraska. He also served as laboratory technician with the Allison Division of the General Motors Corporation. Mr. McCreight served for a period of one and one-half years as aviation ground instructor for the Navy. —C. R. Crakes.

Audio-Visual Aids in Physics

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FOLLOWING are a number of questions asked by high school physics pupils who are undertaking the study of machines: why do animals not walk straight up a steep hill; which turns over faster, the engine or the rear wheels of a car; why does one quickly tire by running up stairs; how much horsepower do your legs develop; do you save work by using an inclined plane; how efficient is a steam locomotive; how do you find the mechanical advantage of a lever; what kind of machine is a clock; what is gained by the use of a large steering wheel on an automobile? In answering these and many other questions, films may often serve effectively in presenting principles needed for an adequate explanation.

The procedure to be followed in considering the classroom use of films in teaching a unit on machines in physics should include these steps: selection and pre-view of film by the teacher; pre-showing orientation and discussion with the class of what is to be studied, including the specific objectives to be realized; showing the film under the best classroom conditions possible; post-showing discussion and development of related activities; post-showing of films to clarify and review; and the evaluation of the film's use.

HOW THE above procedure is applied may be illustrated in the study of the unit on

The students decide to determine the efficiency of an incline plane after seeing it presented in the picture.

Students determine the mechanical advantage of a pulley system.

machines. In beginning the study of the unit considerable thought is given as to how to introduce the material. After investigation, suppose that for several reasons, it is decided that the sound motion picture, "Simple Machines," is the most appropriate audio-visual aid to use. The material is accurate. The instructional techniques are used satisfactorily. The film content matches the age and maturity level of the pupils. The film is short enough to be within the attention span of the students. The contents of the film correlate with the subject matter being studied. At this point the film fulfills a particular purpose, that of stimulating interest, of arousing curiosity, and of introducing a new unit. It serves as a worthwhile aid to instruction.

The teacher becomes thoroughly familiar with the contents of the film by pre-viewing, and by studying the teacher's handbook. In this way the teacher is able to determine definite objectives for using the film, and is able to plan his lessons, accordingly, for correlated projects that will further the study of simple machines.

The pupil's approach to the study of a film can be made much more effective if the teacher sets the stage for the showing of the film by discussing interesting background material which leads into the film content. The day before the film is showed, a number of questions are raised, which suggest objectives for seeing the film. Some of these questions are answered in part by the film. Attention is called to certain sequences which are shown in the picture. As further preparation of the pupils for the film, names of simple machines are placed on the blackboard, examples of machines used every day are listed, more questions are asked than can be answered, the pupils' imaginations are stretched, they are to anticipate something. Much of this introduction causes the pupils to think. The purpose of showing the film, that of giving an overview of the study of simple machines, is made clear to the class.

THE PREPARATION for the projection of the film is made before the class arrives. It is shown under the best physical conditions possible. The film is shown in the classroom at regular class time, and as a part of the day's work, not as something special. A number of pertinent items are listed on the blackboard so that the pupils have something definite in mind to look for while seeing the film.

Immediately following the presentation, the class reviews and reconsiders the film. This is accomplished by discussion, questions and answers, finding out what has been learned, what they still would like to know. In this way the teacher is able to determine the extent to which the purposes of showing the film have been realized, is able to correct any misconceptions which have arisen, and is able to determine if another showing of the film will be necessary. This discussion also assists in directing the pupils' interests in finding answers to their questions through their regular classroom activities. It is suggested by a number of pupils that laboratory experiments be set up in order to study further the laws of simple machines, mechanical advantages of various types and combinations of these simple machines, the efficiency of some commercial machines, and in order to find practical applications of the simple machines.

OPPORTUNITIES for immediate applications of the principles developed by the instruc-

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Home Made Equipment in Teaching General Science

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FIRSTHAND experience is the most effective learning situation. Yet, how many of us have had to learn general science by watching someone else do demonstrations, or by hearing reports, or by reading from books or by some other equally second or third hand device?

Many general science teachers make a genuine effort to have materials available for the children to try for themselves. The responsibility for this kind of program rapidly becomes too much for the teacher alone, but, perhaps much of the checking in and out of these materials can be done by student committees.

Another problem is time. There is seldom sufficient class time available to allow each child to go through the required handling of the materials. Of course this needed time can be provided to the interested ones through the science club or through extra class activities.

However, the real crux of the situation is the junior high school child, himself. He is a queer animal, as you have no doubt discovered. Why doesn't he take advantage of the wonderful opportunities you provide? That is too long a story to tell fully here, but a big part of it is a kind of pride and self respect he possesses. He sees you do a demonstration or hears you tell about it, and maybe would really get a big kick out of trying it, to say nothing of all the little tricks of manipulation and the fuller understanding of principles he would gain. But, he has a great deal of reputation at stake. Rather than risk failure at the hands of a pile of relatively unfamiliar equipment, he will often avoid it entirely or tackle it only as a big joke, or use some other defense against this potential menace.

Try devising and using home made equipment in general science, if you also have run into these problems. Some of the advantages of this procedure are easily seen: (1) responsibility for the large bulk of individual equipment is on the children; (2) most of the time needed in constructing or manipulating can be outside of class, anywhere; (3) the child does not have to expose his reputation to attack until he has become sure of himself and his materials and has built up an offense instead of a defense against the problems involved. This seems much easier for many children to do when they use materials as familiar as bottles, modeling clay, tin cans, tin shears, hammer, nails, saw, cardboard, plaster, glue, etc.

1. SOUND

In the study of sound, don't miss the chance to make drinking glass chimes! This whole study of sound can be organized so nicely around musical instruments and principles—and you may have a fine orchestra of home made instruments before long. For the uninitiated, start with a set of chimes that is simple and yet can be used to play all the military bugle calls—Taps, Assembly, Reveille, etc. For this, you need four drinking glasses, a wooden rod or mallet to tap them with, and an ear that can recognize Sol, Do, Mi, Sol—or a piano to use in tuning them to G, C, E, G. Arrange the empty drinking glasses in the order of their pitch, the lowest one on the left. Fill this low note glass with water so it has the lowest pitch possible, (or the lowest G note possible, if using the piano). Then, pour water into the next glass until its pitch is lowered to Do, using the low note as Sol. Pour enough water into the next glass to sound Mi and the next glass to Sol, one octave higher than the low note. The boys and girls will build sets of these chimes covering many octaves, some including the sharps and flats! However, unless they are made with corked bottles, the water will evaporate and pitches will change.

A closely related, more sturdy musical instrument is the xylophone. A four note one for playing bugle calls is made from lengths of broomstick. With a hacksaw, cut a 10" length. Use a piano to check the sound of this stick when struck with a rod or mallet.

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Science Clubs at Work

Edited by MARGARET E. PATTERSON
Secretary, Science Clubs of America

• A department devoted to the recognition of the splendid work being done by science club members and their sponsors. Material for this department, such as student made projects; demonstrations and posters; outstanding club programs; state and regional meeting announcements; should be sent to Miss Patterson, Science Clubs of America, 1719 N Street, N. W., Washington 6, D. C.

Good Science Projects Need Not be Expensive

MARGARET E. PATTERSON
Secretary, Science Clubs of America

HOBBIES and projects need not be expensive to be scientifically sound. This was proved by many of the forty winners of the Seventh Annual Science Talent Search for the Westinghouse Science Scholarships when they met in Washington, D. C., for the Science Talent Institute February 28 through March 2.

The eight girls and thirty-two boys who unpacked their exhibits for a viewing by the judges, fellow winners, and invited guests on the night of February 29 had won that privilege by passing a science aptitude test, by submitting their scholastic records, and by recommendations from their teachers and principals. They had also written essays about the work they were doing in science.

When she could not afford to buy a micromanipulator, Nancy Jean Rowe, 16, of Lincoln High School, Canton, Ohio, made one with parts from a local hardware store and carried out experiments in microdissection and microinjection. Credit: Science Service.

Learning Methods of Research

ALL OF THE exhibits showed that their builders had mastered some of the methods of research science. By reading or by experience they had learned that research scientists, among other things, must: (1) know the literature of their subject; (2) understand their tools; (3) check their results; (4) keep records; (5) be resourceful; and (6) be adaptable.

Scientists Know the Literature

Each of the two recipients of the Westinghouse Grand Science Scholarships of $2,400 had spent much more time than money on their research projects. Both were fortunate in being able to delve extensively into the literature of their chosen subjects in a school, public, or college library. The time-saving factor of finding out what already has been done is well illustrated by the advanced work the two top winners therefore were able to do themselves.

Barbara Claire Wolff, seventeen, of Forest Hills (N. Y.) High School, worked on fruit flies. These can be obtained by anyone from the nearest rotting banana. But Miss Wolff's work was not routine. From the literature she had learned that it is possible to produce phenocopies—changes in body structure or color by immediate influence of the environment of the larvae—and she set about trying to produce some.

Barbara's equipment consisted of a microscope, a few pieces of glassware, a chemical

solution and a 100-watt lamp—all available in her school. She kept the fruit-fly larvae in a dye, cyanin, for twenty-four hours, then exposed them for twenty or thirty minutes to the rays of the lamp at a distance of nine inches. When they developed into adults she found two of the flies had shortened, humpbacked bodies, and about one-half of them had marked color changes. Her work in this field is only in its beginning stages but she plans to continue the study of phenocopies as she develops her career in genetics.

THE TOP award for boys went to fifteen year old Andrew Steven Kende* of Evanston (Ill.) Township High School. He came to this country at the age of eight from Hungary and has been seriously interested in chemistry for a number of years. He is finishing high school in three years so that he can go on with more advanced training in his chosen field—organic chemistry.

Andrew's project, shown in Washington, developed from his extensive knowledge of his favorite field. He had started experiments with the new organic silicon polymers, silicones, and was struck by the fact that the best reagents for making these new products are dangerous to use because they are dissolved in ether, forming explosive mixtures in air. Since ether acts merely as a solvent in these reactions he began a search of the literature to find some less volatile liquid to be used as a substitute. His reading assured him that apparently no one else had thought of this safety measure, so he deserted the silicones to make a series of experiments on organic solvents for the reagents whose volatility and flash-points would be more on the side of fire-safety. He succeeded in finding that three of the four liquids he tested could be substituted for ether as solvents. The liquids are dibutyl ether, anisole, and diphenyl ether. This information is of considerable importance to the industries using Grignard processes for the synthesis of organic compounds.

Nancy Jean Rowe, sixteen, of Lincoln High School, Canton, Ohio, was already familiar with microscopic techniques since she had access to a school microscope but she wanted to try some microdissection—performing

George Camamis, seventeen, of Ne wBrunswick (N. J.) High School, proved that gold can be extracted from sea water and made some improvements on the method. Credit: Acme.

minute surgical operations on a single living cell under the microscope; and microinjection —squirting ultra-tiny drops of dyes or drugs into them. These operations have to be done with glass needles, drawn out to points finer than human hairs, and held in special mountings moved by fractions of turns of carefully adjusted screws. Commercial micromanipulators were too expensive for a high school student's budget, so Nancy built her own from an ingenious combination of two ordinary machine bolts with different thread pitches, obtained from the local hardware store. She worked one against the other so that the net motion on a full turn would be one-eighth of an inch. This is sufficiently slow motion to permit the handling and injection of cells. For the actual injection, she attached a hypodermic syringe to her hollow glass needle with a piece of flexible tubing. Miss Rowe plans to secure an M. D. degree and do research work in bacteriological fields. Like Mr. Poindexter she learned a lot by building and using a piece of apparatus which gave results similar to that given by expensive standard equipment in that field.

Why musical instruments are made as they are puzzled Alan Richard LeSchack, sixteen, of Stuyvesant High School, New York, so he chose an inexpensive project of investigating the mathematical reasons for the graceful curve at the top of a harp. Since he plans to

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*Essay appears in full in *Chemistry*, March ,1948.

Summer Convention

National Science Teachers Association, July 3, 4 and 5, 1948

(Meeting Currently with the 85th Annual Meeting of the NEA)

Thousands will travel to Cleveland to participate in the summer meetings of the National Education Association. Classroom teachers of science, supervisors, school administrators, and others interested in the growing problems of science education are invited to participate in the summer convention of the National Science Teachers Association. This Association is a department of the National Education Association.

PROGRAM

Saturday, July 3

Room 309, Board of Education Building
1380 East Sixth Street
Presiding: Morris Meister, President.
National Science Teachers Association.
9:00 A. M. to 12:00 Noon

1. Business meeting of officers and members of the Board of Directors and others interested.

1:00 P. M. to 4:00 P. M.

2. Business meeting of officers and members of the Board of Directors and others interested.

4:00 P. M. to 5:00 P. M.

3. A conducted tour of and presentation of the activities of Radio Station WBOE. (For officers and members of the Board of Directors and others interested.) In charge of: Edwin F. Helman. Directing Supervisor of Radio Station WBOE.

7:00 P. M. to 10:00 P. M.

4. Business meeting of officers and members of the Board of Directors and others interested.

Sunday, July 4

In charge of: Paul R. Young. Supervisor of School Gardens, Cleveland.

A conducted tour by automobile, for the officers and those in attendance at the Board of Directors' meeting will include visits to School Gardens, Trailside Museums in the Metropolitan Parks, and a picnic lunch at the lodge of the Cleveland Natural Science Club. Transportation will be provided by Cleveland members of the group.

The tour will start at 9:00 A. M. from the Mall side of the Board of Education Building. Reservations for transportation and for lunch, will be taken at the Saturday sessions. It is planned to return to the downtown area not later than 5:30 P. M.

Monday, July 5

Board of Education Building
(Room to be announced)
1380 East Sixth Street

General Program open to all classroom teachers, supervisors, school administrators, and others interested in science education.

9:00 A. M. to 12:00 Noon

Presiding: Arthur O. Baker, Directing Supervisor of Science, Board of Education, Cleveland.

1. *Welcome to Cleveland* (10 minutes). Mark C. Schinnerer, Superintendent of Schools, Board of Education, Cleveland.
2. *Outlook in Science Education* (20 minutes). Morris Meister, President of the National Science Teachers Association, Bronx High School of Science, New York City.
3. *The Work Week of the Science Teacher.* Earl R. Glenn, Past President of the National Association for Research in Science Teaching, New Jersey State Teachers College, (15 minutes); and Harold E. Wise, Professor of Education, University of Nebraska, (15 minutes).

(A panel discussion will be presented on the research which Earl R. Glenn and Harold E. Wise have conducted—30 minutes).

Panel Participants

James C. Adell, Bureau of Educational Research, Board of Education, Cleveland.
Robert R. Finlay, Instructor of Conservation, John Marshall High School, Cleveland.
Grace C. Maddux, Assistant Supervisor of Science, Board of Education, Cleveland.
Gjertrud Smith, Supervisor of Science and

Mathematics, Board of Education, Los Angeles.

Intermission

Presiding: Anna E. Burgess, Directing Principal, Board of Education, Cleveland.

4. *A Visual Record of Elementary Science Teaching in the Greater Cleveland Area.*
   a. Teaching Physical Science at the Elementary Level (10 minutes). Viola Neuman, Principal, Curriculum Center for Elementary Science, Miles Standish School, Cleveland.
   b. Out-of-doors Science Education in the Cleveland Heights Elementary Schools (15 minutes). Verna Lewis, Third Grade Teacher, Cleveland Heights.
   c. Using the Natural History Museum for Teaching Elementary Science (10 minutes). Elsie Michel, Museum Teacher, Cleveland Museum of Natural History.
   d. Making Children's First-Hand Experiences Serve Science Understandings (10 minutes). Marian P. Schutler, Special Teacher Assigned to the Flementary Science Curriculum, Lakewood Public Schools.
   e. Making Elementary Science Rooms Interesting (10 minutes). Mildred Chamberlain, Elementary Science Teacher, Kentucky School, Cleveland.

1:00 P. M. to 4:00 P. M

Presiding: James C. Adell, Chief, Bureau of Educational Research, Board of Education, Cleveland.

1. *Science Teaching in the State of New York.* Paul Brandwein, Forest Hills High School, New York City (15 minutes). (A report and a panel discussion will be presented pertaining to the research conducted by a Committee of the NSTA: Donald Kumro, Carleton Moose, Theodore Shull, Zachariah Subarsky and Paul Brandwein, Chairman—30 minutes).

Panel Participants

James W. Gebhart, Instructor of Science, Shore High School, Euclid, Ohio.
Elbert C. Weaver, Phillips Exeter Academy, Massachusetts.
Hanor A. Webb, Secretary, National Science Teachers Association.
Alton Yarian, Vice-President, Cleveland Regional Council of Science Teachers.

2. *Science Problems of National Significance* (30 minutes). W. Edgar Martin, Assistant Specialist for Biological Sciences, U. S. Office of Education, Washington, D. C.

Intermission

Presiding: Grace C. Maddux, Assistant Supervisor of Science, Board of Education, Cleveland.

3. *Conservation Education in the Greate Cleveland Area.*
   a. Outlook on Conservation Education Problems (20 minutes). J. Paul Visscher, Professor of Biology, Western Reserve University, Cleveland.
   b. Park Protection Clubs (10 minutes). Anna E. Burgess, Directing Principal, Board of Education, Cleveland.
   c. A Junior High School Conservation Museum Project (10 minutes). Charles W. Collins, Science Teacher, Myron T. Herrick Junior High School, Cleveland.
   d. The Conservation Project at John Marshall High School (15 minutes). Robert Finlay, Conservation Teacher, John Marshall High School, Cleveland.

MATHEMATICS

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for talented youth would be effective, no one can say. The education of gifted children in separate groups is one of the relatively new programs in public educaiton. It could turn out that a comprehensive investigation of the problem might show that the finest algebra and geometry courses of the traditional type are not the best mathematics courses that can be provided for the future scientist. The fact is that the typical first-year algebra course does not nurture scientific aptitudes and certainly is not realistic as regards problem material, to say nothing of an emphasis on the method of science. As long ago as 1902, closer correlation of mathematics and science was suggested by Eliakim H. Moore, when he asked his now famous question: :'Would it be possible to organize the algebra, geometry and physics of the secondary school into a thoroughly coherent four years' course, com-

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This and That

NORMAN R. D. JONES
Vice-President and Membership Chairman

Dr. Glenn T. Seaborg of the University of California received the 1948 John Ericsson Gold Medal at the 60th Anniversary Dinner of the American Society of Swedish Engineers. This medal is awarded to a Swedish subject or to an American citizen of Swedish descent. He received the award for his work as co-discoverer of elements 94, 95, and 96.

The California Science Teachers Association, Northern Section, will have a field trip to the beach under the guidance of San Jose State College at its May meeting.

The Southern Section of the above met jointly with the Southern California Chemical Society with Dr. Glenn Blough of the U. S. Office of Education as its main speaker. Officers elected were Owen T. Gothard, president; Miss Archie MacLean, vice-president; and Miss Elizabeth Butcher, secretary-treasurer.

Dr. Felix Zeller of Austria recently wrote asking for information concerning school organization and administration in the various parts of this country.

In a recent letter, Mr. F. Daniel, the Malaya School's Science Supervisor, enclosed some interesting pictures. The signing of Japanese surrender for that part of the world had taken place in their building. In addition to pictures of their building and of the actual signing of the surrender, he wrote the above mentioned letter on the table used to sign the surrender.

Dr. R. C. Evans, our first member from the British Science Master's Association, who has written several articles for their journal about N.S.T.A., is General Secretary of the International Union of Crystallography. The First General Assembly and International Congress of the Union will be held at Harvard University, July 28-August 3, 1948. Dr. Evans will come to this country for the meeting. Those desiring to attend should address Dr. Evans at the Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England.

In a recent letter, Mr. Robert Molkenbur of St. Paul, an N.S.T.A. Area Director, enclosed a very interesting mimeograph publication entitled, "Academy Rumblings." Mr. Molkenbur is chairman of the Minnesota Junior Academy of Science. He also gave some very interesting data on a follow-up study of his former students.

Dr. Philip G. Johnson of the U. S. Office of Education recently spent two days in St. Louis. He was enthusiastically received by the St. Louis High School Science Teachers. On his return, he spoke before the Tennessee Science Teacher's Association, an N.S.T.A. affiliate.

Mr. Russell Meinhold, Rhode Island State Director, received a nice promotion in accepting a position at the Rhode Island College of Education.

Judging by words of commendation received, the First Greater St. Louis Science Fair was very successful.

New Affiliations

Marion U. Greer of Ponca City, and Mrs. Mariam Nelson of Oklahoma City, our Oklahoma Directors, were leaders in organizing the Oklahoma Science Teachers Association recently. Mr. F. A. Swanson of Oklahoma City was elected as president for the coming year.

Sister M. Jude of the Convent of Saint Thomas The Apostle writes that the Chicago Catholic Science Teachers voted affiliation with N.S.T.A. at its meeting on March 29th. She was selected as the N.S.T.A. consultant for the group.

The San Diego Science Teachers Association, one of our three very active science groups in California, voted affiliation with N.S.T.A.

New Directors

Mr. Robert P. Hollar, High School, Roanoke Rapids, North Carolina.

Mr. Russell Meinhold, College of Education, Providence, Rhode Island.

Deceased

Dr. George Hunter of Claremont College.

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Science Rooms for Secondary Schools

A Standard Proposed by Dr. Morris Meister for Consideration and Adoption by the NSTA

Point of View

The products of scientific research during the past few decades have altered our ways of living. These changes include not only a host of technological applications, about which every citizen must be intelligent, but also a method of solving problems and a scientific outlook. The secondary school must achieve a two-fold objective through its program of science studies. First, it must contribute to the general education of all pupils. Secondly, it must locate and further the development of science talented youth. Unless it achieves the latter purpose, an important national human resource will be wasted. Unless it achieves the former objective, the people will not support the plans, efforts and recommendations of our scientists and technologists. Neither objective can be adequately attained in the secondary schools without properly designed and equipped science rooms.

The generally accepted program of science teaching in secondary schools is conducted in a group of specialized rooms provided with special facilities and equipment. The learning outcomes and teaching procedures in science are uniquely dependent upon the availability of these facilities. Teachers, laboratory assistants and pupils devote a large portion of their time and energy in procuring, devising, organizing, caring for, repairing and manipulating a vast array of teaching materials. To a large extent, existing practices in science teaching, in so far as they include the use of this specialized equipment, are the result of analysis, research and testing.

Ten Guiding Principles

1. *In general, a science room is a place where the pupil may receive educative experiences which give better understandings of those generalizations in science that contribute to the enrichment of life.*

The emphasis here is on the word *experiences*. As here defined, the science room is a means to an end rather than an end in itself. It is not intended that the pupil in such a room shall imitate the research workers, except in the sense that he, too, is gathering evidence on the basis of which he will arrive at conclusions. The room must make it possible for the teacher to so "set the stage" that questions can be put to nature and answers be derived through observation and reason on the part of pupils.

2. *The experiences for which science rooms shall provide are justified by, and take their origin from, the prescribed program of science studies.*

Practice based on this principle will avoid teaching which is organized around facilities that chance to be available. While the program of science studies tends to change more rapidly than building and equipment, it is possible to plan rooms and facilities in such a way as to make adaptations and change reasonably possible. The recommended group of science rooms presupposes the following sequence of science studies in the secondary school:

Ninth grade	—General Science
Tenth grade	—Biology or Applied Chemistry or Applied Physics
Eleventh grade	—Physics or Chemistry or Earth Science
Twelfth grade	—Physics or Chemistry or Earth Science or Special Science

3. *A science room or facility must be evaluated in terms of the educative experiences which it makes possible.*

It is probably true that no necessary correlation exists between the cost of a facility and its educative value. Yet it is often also true that teachers of ability and experience must devote a major portion of their energies to overcoming handicaps due to the lack of proper facilities. A costly item of equipment is justified if its contribution is great over a long period of time, and if it releases the teacher's energies in the right directions.

4. *A science room must be a place where the*

experience in problem-solving is possible.

The effect of this principle is not so much a matter of radical change in design and equipment as it is in attitude toward the use and organization of facilities. The latter must provide for individual differences and special abilities. It must make possible the exploration of pupil interests and capacities. It must provide factors of enrichment. It must be noted that problem solving requires some degree of skill in manipulating science materials, and instruments of measurement. In short, this principle justifies the various laboratories in which pupils can themselves carry on experiments adapted to their level of maturity and understanding.

5. *The design of both science classrooms and laboratories should provide facilities for effective teacher and pupil demonstration.*

The work of many investigators has called attention to the value of demonstration teaching. Demonstrations are essential to many types of learning in science. Many laboratory exercises can be more effectively presented as teacher or pupil demonstrations. In planning science rooms, therefore, considerable attention must be given to this activity. The size, position and equipment of the demonstration table are matters of importance. Visibility, illumination, accessories, proper display, convenience, time-saving and labor-saving devices, and the avoidance of waste motion are all factors to be considered.

6. *Certain science rooms should provide facilities for individual laboratory work.*

Manipulative skills, resourcefulness, and facility in problem solving can come best from a teaching procedure which enables pupils to experience individually. At least three types of activities must be possible in a laboratory.

a. Exercises required of all pupils and requiring multiple sets of equipment which develop better understanding and skill in manipulation.

b. Laboratory exercises from which students may select in accordance with special needs and interests.

c. Exercises originating in problems formulated by pupil or teacher. These problems may be original or may be modeled after some basic research or discovery.

7. *Science rooms should provide certain facilities for objectification by means other than use of concrete materials.*

This guiding principle calls attention to such items as the blackboard, bulletin board, display fixtures, charts, and especially the rapidly developing class of facilities referred to as audio-visual instruction. Often these facilities can provide experiences as real to the pupil as are many of the demonstrations and the laboratory exercises. They may surpass the latter in variety, clarity and pertinency. Occasionally they may supplant a demonstration or laboratory experience involving hazards or exorbitant cost or a complicated skill not to be expected at the secondary school level. Hence science rooms must include facilities for the operation of such devices as the motion picture, radio, sound recording and production, and television.

8. *The planning of science rooms and their equipment should be a cooperative project in which the architect, the engineer, the educational supervisor and the science teacher each play a proper part.*

The experience and knowledge of each of these individuals must not be ignored. Great saving in cost and increased efficiency in use can result from cooperative planning. Among the important questions that such planning must answer for each school in advance of construction are:

a. How large shall the science rooms be?

b. How many pupils shall they accommodate?

c. How shall the science rooms be grouped?

d. On what floor shall science rooms be located?

e. How shall preparation rooms and storage rooms serve the needs of science classrooms and laboratories?

9. *In schools designed for 1,500 or more pupils, the numbers enrolled in science courses and the number of science teachers involved are such as to require facilities that can best be administered by laboratory assistants.*

Since the teaching load of science teachers is usually the same as for teachers of other subjects, science teachers must have the service of laboratory assistants. This, in turn, presupposes the availability of preparation rooms where materials can be effectively or-

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Summary Report of the First Conference of the Advisory Council on Industry-Science Teaching Relations

Hotel Chalfonte, Atlantic City, New Jersey, February 21, 1948

I. INTRODUCTORY

This meeting is an outgrowth of the N.S.T.A. Conference held at the Hotel Sherman in Chicago on December 28th, 1947. The Conference was attended by more than three hundred representatives of industry and science teaching. The Conference, after full discussion, passed a resolution urging that an Advisory Council on Industry-Science Teaching Relations be established for the purpose of formulating recommendations with reference to various activities, programs and procedures in which industry and science teachers could cooperate more effectively. Acting upon this resolution the President of N.S.T.A. with the advice of its Executive Committee, appointed a Council as indicated below. The President also issued a call for the first meeting of the Council to be held at the Hotel Chalfonte in Atlantic City on February 21, at the time of the convention there of the American Association of School Administrators. The following individuals were appointed members of the Council.

1. Mr. Lansing T. Carpenter
   Assistant Director Public Relations
   U. S. Rubber Company
2. Mr. Chapin Collins
   Managing Director
   American Forest Products Industries, Inc.
3. Dr. Earl Glenn
   Professor of Physics
   Montclair Teachers College, N. J.
4. Mr. D. B. Hobbs
   Public Relations in Charge
   Educational Activities
   Aluminum Company of America
5. Dr. James K. Hunt
   Technical and Educational Activities
   E. I. DuPont deNemours & Company
6. Dr. Philip Johnson
   Specialist in Science
   Secondary Schools, U. S. Office of Education
7. Mr. Charles MacLean
   Director of Educational Research
   Byron G. Moon Company
8. Dr. Morris Meister
   Prin., High School of Science
   Bronx, N. Y.
9. Mr. R. O. Mertes
   Director of School and College Service
   United Air Lines
10. Mr. Nathan Neal
    Cleveland Board of Education, Ohio
11. Mr. Gilbert O'Connell
    Dept. of Public Relations
    Assistant Director of Educational Service
    General Motors Corporation
12. Mr. G. Edward Pendray
    Public Relations Counsel
    Pendray & Leibert, N. Y.
13. Dr. Howard Prentice
    Associate Director
    Corn Industries Research Foundation
14. Miss Bertha E. Slye
    Director Membership Service
    NSTA Headquarters
15. Mr. A. C. Stevens*
    General Electric Company
16. Mr. Zachariah Subarsky
    High School of Science
    Bronx, N. Y.
17. Mr. E. C. Weaver
    Chemistry and Physics
    Phillips Academy, Mass.
18. Dr. Hanor A. Webb
    Professor of Chemistry and Science Education
    Peabody Teachers College, Tenn.
19. Mr. R. E. Williams
    Director of Educational Service
    Standard Oil Company of N. J.
20. Dr. Harold Wise
    Department of Physics
    Lincoln Teachers College, Nebr.

*Acceptance not yet received.

II. RESUME OF AGENDA OF ADVISORY COUNCIL CONFERENCE ON FEBRUARY 21

A. Attendance. Sixteen of the twenty Council members were present.

B. A resume was presented of the high lights of the Chicago Conference, the detailed minutes of which had been circulated to everyone who attended the Chicago Conference as well as all N.S.T.A. Directors.

C. The history and present activities of the N.S.T.A. were briefly presented.

D. A full report of the N.S.T.A. Committee on Projects was distributed and briefly discussed.

E. A mimeographed digest of the N.S.T.A.-Wise report on specifications for commercial materials was distributed and briefly discussed.

F. A brief report was presented on the N.S.T.A. packet service of science information for teachers, together with the latest brochure on Packet IV.

G. General discussions followed based upon the following leading questions:

1. What are the different types of educational programs which call for closer copperation between industry and science teachers?

2. What has industry to gain from such cooperation?

3. What have science teachers to gain from such cooperation?

4. What are the most important and immediate problems to be solved?

5. How can better organization among representatives of industry and better organization among science teachers contribute to the solution of these problems?

H. Appointment of sub-committees. In the light of the discussion the group was divided into four sub-committees. These committees met independently at lunch and formulated a series of recommendations.

I. Reports and recommendations of the Sub-committees.

Sub-committee A on Finance (Prentice, Chairman, Hunt, MacLean, Meister, Neal and Slye.) The following recommendations were presented,

discussed and unanimously adopted by the Advisory Council:

1. That the evaluation and distribution fee for items in the packet of science information for teachers be increased to a minimum of $100.00 per item and that a proper budget be developed for the packet service.
2. That industries be solicited for grants-in-aid by the Advisory Council, on Industry-Science Teaching Relations of N.S.T.A.; funds so raised to be exclusive of the packet service and to be used for the planning and development of educational projects of benefit to both industry and science teaching in the schools of America.
3. That a committee of three be appointed by the Chairman of the Advisory Council to take immediate steps to solicit $1,000.00 with which to initiate the plan proposed in Reccomendation 2 above.

Sub-committee B on Organization and Function (Johnson, Chairman, Carpenter, Glenn, Mertes, O'Connell and Williams.) The following recommendations were presented, discussed and unanimously adopted:

1. The Advisory Council as now constituted shall be continued for a formative period of three years. Its membership shall be extended to ten representatives from industry and ten representatives from science teaching.
2. The officers elected by the Advisory Committee shall continue to serve during this period of three years. Meister was elected chairman and Slye was elected secretary, each to hold office during the formative three year period.
3. The present N.S.T.A. policies with reference to the development of a consultation service shall be continued.
4. The Council shall meet at least three times a year for the purpose of clarifying policies and plans.

Sub-committee C on Programs and Techniques (Webb, chairman, Subarsky and Tuttle.) The following recommendations were presented, discussed and unanimously adopted:

1. Areas of industrial production should be surveyed as to the following aspects:

   a. Can (or should) these production processes be presented to science classes as important information?

   b. In what form should they be presented, for best effect? Forms are booklets, charts, enlarged photographs, film strips, motion picture films, display of objects, etc.

   c. On what level should the presentation be made? Levels are adult (teacher only), senior high, junior high, intermediate grade, elementary grade.

   d. Should take-home material, to interest parents, be designed?

   e. Should the material be distributed only on request, or by some other form of addressing?

   f. Should the amount of distribution be planned in large quantities for certain types of material, and restricted quantities for other types? What are the criteria for large distribution? For restricted distribution?

   Note: Distribution of three and four million have been made of certain types of educational material.

   Query: If distribution by the millions is impracticable because of the cost of an item, might it not be advisable to plan the item in less expensive form, and attain the larger distribution?

2. Periodicals now planned for employes circulation are often worthy of much wider circulation among teachers. The house organs and publicity magazines of various industries should be surveyed to determine whether they would be suitable for distribution to science teachers. Slight modifications might be advisable in some periodicals. They might be free, or at a low subscription price.
3. Workshops for science teachers. A plan would involve the selection of a suitable number (about 50) of science teachers in a certain area (probably 200 miles radius) to be invited for a visit of reasonable duration (probably three or four days) to the laboratories and factories of an important industry. All, or a substantial portion, of the teachers' expenses should be paid by the industry. The workshop should consist of lectures on the scientific principles involved, and observation of the processes. The aspects of social values of the products should be included.
4. Speakers from industry at teachers meetings. A touring service could be arranged by which technical and research men in industry, who have speaking ability, could address a series of meetings of science teachers.
5. Visits to schools. Arrangements could be made for a number of industrial men to visit one or more schools where the educational materials prepared by industry were being used most effectively.
6. A film on use of material. A film could be prepared entitled "How To Use Industrial Material in Science Classes." It would start with the planning of the material by men in conference, the writing or other preparation, the publishing or assembling, the distribution (in which the N.S.T.A. office renders service), the receipt of the material by a teacher, the assignment of its use, the actual use of the material by students, the follow-up and expanded interests, and similar aspects, all in sequence. This film would be shown in teachers meetings, summer school classes of teachers-in-training, and in other appropriate educational gatherings.

Sub-Committee D on Evaluation, Distribution and Utilization (Hobbs, Chairman, Weaver and Batchelder). The following recommendations were presented, discussed and unanimously adopted:

1. The evaluation procedures shall continue to function on the same basis as developed by N.S.T.A. In selecting members of Evaluation Committee preference shall be given to active class room teachers. There shall be no industry representatives on the Evaluation Committee. Advice of specialists shall be sought when necessary.
2. An appropriate phrase shall be developed that can be imprinted on materials which are in accord with the requirements of the Evaluation Committee. However, the phrase shall not include such words as "approve", "endorse", or "recommend". For example, "This (booklet) (chart) (motion picture) fulfills the evaluation standards of the National Science Teachers Association."
3. The method of distribution developed by N.S.T.A. shall be continued. N.S.T.A. shall release to school publications and to teacher training institutes annotated lists of materials that fulfill the standards of its Evaluation Committee.
4. In order to reduce waste requests that come from teachers to industry N.S.T.A. shall publish

Continued on Page 80

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Report of NSTA Nominating Committee for 1948-9

Dear Member:

The procedures utilized by the Nominating Committee in selecting the nominees whose names appear on the ballot were as follows:

1. Immediately following the appointment of the Committee on January 16, 1948, each member of the Committee suggested three or more names for each of the thirteen offices to be filled. In making these suggestions each Committee member made use of lists of consultants and of State and Area Directors which have appeared in recent issues of *The Science Teacher*.
2. A preferential ballot was prepared on which there appeared under each office all names which had been suggested for this office by two or more members of the Nominating Committee. This procedure yielded from three to six names for each office.
3. The preferential ballot was checked by each member of the Committee and the final slate prepared in accordance with majority preference.

The Committee has followed the custom of past years of submitting only one nominee for each office. However, the possibility of a write-in-vote has been provided and the possibility of one person serving in two capacities has been eliminated. The nominees represent a range of interest in science education extending from the elementary schools through the secondary schools and into the colleges and universities.

If for any reason you did not receive your ballot by mail, you can obtain one by writing to Miss Bertha E. Slye, 1201 Sixteenth Street, N. W., Washington, D. C. Ballots must be mailed by May 10, 1948.

Committee on Nominations

Arthur O. Baker	Elmer Headlee
Paul Brandwein	Hugh C. Muldoon
W. Bavard Buckham	Elbert C. Weaver
Anna Burgess	Harold E. Wise
Robert H. Carleton	(Chairman)

THE BALLOT

Check:

For President, 1948-49 (Vote for 1)

..... Mr. Norman R. D. Jones, Biology Teacher, Southwest High School, St. Louis, Missouri.

For President Elect, 1948-49 (Vote for 1)

..... Mr. Nathan A. Neal, Director Radio Education, Board of Education, Cleveland, Ohio.

Retiring President, 1948-49 (Automatically Elected)

Dr. Morris Meister, Principal, High School of Science, New York City.

For General Vice-President, 1948-49 (Vote for 1)

..... Mr. Ralph W. Lefler, Physics Department, Purdue University, Lafayette, Indiana.

For Secretary, 1948-49 (Vote for 1)

..... Dr. Hanor A. Webb, Professor of Chemistry and Science Education, Peabody College, Nashville, Tennessee.

For Treasurer, 1948-49 (Vote for 1)

..... Mr. Elbert C. Weaver, Instructor in Chemistry, Phillips Academy, Andover, Massachusetts.

For Eastern Vice-President, 1948-49 (Vote for 1)

..... Dr. Walter S. Lapp, Chemistry Teacher, Philadelphia, Pa.

For North Central Vice-President, 1948-49 (Vote for 1)

..... Mr. Emil L. Massey, Supervisor of Secondary School Sciences, Detroit, Michigan.

For Southern Vice-President, 1948-49 (Vote for 1)

..... Miss Greta Oppe, Chemistry Teacher and Head of Science Department, Ball High School, Galveston, Texas.

For Western Vice-President, 1948-49

..... Mr. Bavard Buckham, Teacher of Physical Science, High School, Oakland, California.

For Directors-at-large, 3 year term (Vote for 4)

..... Dr. Glenn Blough, Specialist for Elementary Science, U. S. Office of Education, Washington, D. C.

..... Mr. Robert H. Carleton, Department of Physical Sciences, Michigan State College, Lansing, Michigan.

..... Mr. Leo J. Fitzpatrick, Brockton High School, Brockton, Massachusetts.

..... Dr. Dwight E. Sollberger, State Teachers College, Indiana, Pennsylvania.

SUMMARY REPORT

Continued from Page 78

an article or series of articles in several school magazines. This article or these articles shall discuss intelligent teacher requests as well as effective utilization of commercially prepared material at different grade levels as well as for informal adult use.

J. Publicity.

The Council further recommends that a report of the Atlantic City Conference be distributed to all members of the Council and that a suitable news release on Council Activities be sent to:

1. Officers and Directors of N.S.T.A.
2. All those who attended the Chicago Conference and are still interested in the activities of the Council.
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EFFECTIVENESS OF TEACHING

Continued from Page 58

existing about us. Practically 100 per cent of man's present day food and fiber supply comes from domesticated plants and animals. In addition, most of the recognized, successful medical and surgical methods were developed through the use of laboratory animals, such as mice, rats, rabbits, dogs, guinea pigs, pigeons, chickens, frogs, and fish. As most people will admit, many of the results attained in medicine and surgery are very successful! What is the biological inference that may be drawn from these examples? We leave that to you. If a fundamentalist boycotts foods and fibers from domesticated plants and animals, and medical and surgical methods because the process of evolution is involved, it is not long until he is in serious difficulty. Actually he declares no boycott but simply ignores the problem.

In the country-wide survey[6] of 1942, another relatively unpopular subject, as far as being included in biological courses is concerned, was that of sex education. Out of 2,900 replies only about one third indicated that the topic was taught. A similar survey[7] conducted in a rural county of Pennsylvania in 1946 indicated that 40 per cent of the schools had no sex instruction. When taught, ordinarily it is included in biology courses, however it may be presented either as straight biology or in hygiene, physiology, botany and in physical education. All the processes and structures of the human body are openly discussed without restraint, with the exception of those concerning sex. Adolescent boys and girls are curious about their bodies and how they work. Ordinarily they are left to their own devices for getting the information on the streets and in disreputable places. Our schools should be a source of dependable information concerning this fundamental phase of human biology. The school should aid boys and girls in developing a wholesome attitude toward sex

6 Riddle *et al*, 1942.

7 Knepp, Thomas H., Biology Teaching in the High Schools of Monroe County, Pennsylvania. Proc. Pa. Acad. Sci. 20:53-56. 1946.

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and toward each other. Sex is the basis for numerous psychological disturbances in many persons. Sex maladjustment is responsible for many broken homes. Juvenile delinquency is on the increase.[8] A large percentage of these cases are sexual delinquents. About 20 per cent of those arrested for sex crimes in 1946 were persons under eighteen years of age. This is a serious charge against the moral and social education of the children of the United States. Our schools should make every possible effort to better this situation through sex education. At present the schools are handicapped in that many biology teachers are not adequately trained in the subject, and most biology textbooks contain nothing on human reproduction, or at best a very inadequate amount.[9] However, something vastly more tangible can be done and is being done in a few places. As one example, a new course which has a unit on sex education, is being presented in the Arsenal Technical Schools of Indianapolis.[10] The principal, Mr. Hanson H. Anderson, says "The entire course entitled 'Family Relations', which contains a unit on sex education, has proved popular and is well received by parents and the public. There has been absolutely no criticism on the part of the members of the class taught or from the parents. The only criticism which I have received has been from a few members of my own faculty that the one unit of work was too frank and open. On the contrary, parents have told me that the school is accomplishing something which they know not how to do, but which they are willing for their boys and girls to know. A large part of the success of such a delicate subject hinges on the personality of the instructor and his method of approach. My opinion is that it is time that secondary schools were taking hold of this part of the education of adolescents."

IN CONCLUSION, it would seem from the few examples chosen from different phases

8 Uniform Crime Reports for the U. S. and its Possessions. Issued by the F.B.I., U. S. Dept. of Justice, Washington, D. C. Semiannual Bul. 1946.

9 Knepp, Thomas H., Sex Instruction in the High School. Turtox News 25:57-62. 1947.

10 Facts stated in a personal communication.

Continued on Page 86

GAY-LUSSAC'S LAW

Continued from Page 66

Mr. Meister's explanation of the lack of individualized laboratory work in our high schools. He contends that the fundamental reason is not the lack of equipment and facilities, but that it is the use of the "Cook Book Method."

He advocates that a discussion period be held before the experiment is performed in which the teacher leads the pupils through the reasoning behind the process and performs the experiment as a demonstration. As the student in the laboratory merely repeats what he has seen performed in the class room, this method might be referred to as the "warmed over method."

How much interest will the better students have in an experiment that they have already seen performed and heard discussed? Where is the experimental approach, the scientific method, the spirit of investigation, the original research that we claim for our students in science?

For the poorer students, it is no less mechanical to repeat the operations of a previously observed demonstration than it is to follow the instructions given in a manual. Whether or not an operation is mechanical does not depend on how or where the instructions for the performance were obtained. It depends more on the knowledge that the student has of why he is doing it and of what he is accomplishing.

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DEMONSTRATING PHYSICS

Continued from Page 65

ether vapor. The total pressure within the flask rises above atmospheric pressure without affecting the water vapor content. Sudden release of this pressure causes the necessary cooling throughout the volume of gas and consequent cloud formation.

Moral: "When you talk about the weather, bring in a sample to look at." The relation of this experiment to the famous Wilson Cloud Chamber is apparent. This important tool of modern atomic and nuclear research is also one of the simplest in principle.

ETHER BOILS at about 35° C, so it is excellent for making a vapor pressure fountain. Into a strong spherical flask containing warm water at 50° or 60° C, thrust a single hole stopper containing a glass tube that reaches nearly to the bottom of the flask. Attached to the tube is a small open vial containing a few cubic centimeters of ether (Fig. 3). When the ether begins to boil, its vapor pressure is great enough to eject water forcibly from the tube. There is nothing quite so appealing to students as the sight of a jet of water ready to be aimed in any direction. With this arrangement it is not hard to squirt water 20 feet.

Moral: "Don't put your students to sleep with ether; use it to wake them up!" Ask them where the *energy* comes from to push the water out of the flask. You might ask yourself the same question.

AUDIO VISUAL AIDS

Continued from Page 68

tional film follow in the form of laboratory experiments, involving levers, inclined planes,

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wheels and axles, and systems of pulleys. (See picture).

During the working of class experiments by the pupils, questions are raised by them regarding the parts of the film not fully understood. At this point another showing of the film is given for several reasons, namely, to review the unit, to clarify any misconceptions, to answer questions not previously answered, to discover further interests, and to further an appreciation of man's use of these machines.

In concluding work on simple machines, further activities are initiated, such as the charting of uses of all simple machines, making applications to modern machines, giving oral reports on special readings, listing of types of tools and their functions as employed in modern living, and studying the sources of power—man, animal, wind, water, etc.

By evaluating the use of this film a number of things are realized. Interest is aroused in activities about to be suggested. True mental impressions are given to the learner at the time he first learns of simple machines. The pupil is better able to grasp the ideas of the unit due to broadened sensory experiences. Impressions are intensified which facilitate learning. Instruction is vitalized as objects become more realistic. Textbooks and laboratory work are supplemented, clarified, and enriched.

EFFECTIVENESS OF TEACHING

Continued from Page 83

of biology, that many teachers fail to have clear-cut objectives in their courses largely as a result of inadequate training. In a good many instances there is a lack of understanding on the part of the teacher, of many biological phenomena and how they are related to present day human problems. Too often they fail to appreciate the value of using living organisms in the classroom and that of extending the laboratory to the field of the local community. Students should be given adequate opportunity to make observations, to experiment, then to use the facts observed in solving specific problems, or in the derivation of principles. The development of the scientific attitude and the scientific method of approach should be important goals in

teaching the biological sciences. These faults are not directly those of the teachers. Rather, the responsibility lies with the system which allows them to become teachers of the subject and with the college or university in which they received their training. It is imperative that the institutions training biology teachers give more serious attention to this problem. Too often it is assumed that a student who has taken the general course and one or two advanced courses in the subject, has had sufficient background of facts and principles so that he can relay this subject successfully to a high school class. The foregoing illustrations in this discussion do not bear out this point. These college courses too often fail to transfer breadth of understanding or comprehension even within the field of biology. Our colleges and universities should offer methods courses, taught by thoroughly trained biologists, and designed specifically for training prospective biology teachers, enabling them to appreciate the objectives of the field of biology more clearly in relation to the great problems of the biological world.

SCIENCE ROOMS

Continued from Page 76

ganized for use by 8 to 10 science teachers, both for demonstrations and for individualized laboratory work. Adequate preparation rooms and storage facilities will pay for themselves in the long run through lower maintenance and replacement cost. Without such facilities, large schools are compelled to reduce drastically, or even to eliminate, demonstrations and laboratory experiences for pupils.

10. *Adequate provision for science talented youth demands the special facilities referred to as biology and physical science project rooms.*

While the elementary laboratory rooms and science recitation rooms will meet the needs in general education, the science project rooms provide an outlet for the interests of those gifted in science. The latter rooms must be so designed as to make creative work possible. They also provide facilities for the science teacher to continue his professional development. They are also the basis for an in-service training program for science teachers.

New Developments in Science

One of the first things science teachers look for in a new textbook is the treatment of *new developments in science.* Such treatment should be 1) scientific, not popularized, and 2) within the scope of the average high school course.

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MATHEMATICS

Continued from Page 73

parable in strength and closeness of structure with the four years' course in Latin?"[4] As the outcome of Moore's suggestion there have been several extensive efforts to define the kind of mathematics program that he had in mind. Industries such as the Ford Motor Company and the Chrysler Corporation have designed and sponsored mathematical units in textbooks that do not follow the pattern of the traditional courses in mathematics. Finally, we may note that much of the training program in the schools of the armed forces, designed for students who had to learn something in a hurry, took the form of a correlation of mathematics, industrial arts, and simple physics. Therefore, the Cooperative Committee recommends that a scientific study be undertaken to explore the mathematical needs of students with scientific aptitudes and to design a new course of study in mathematics in the event that one is indicated.

It may of course turn out that the traditional courses are the best fit. In fact, there was not much criticism of them by persons responsible for the training programs in the armed forces. On the other hand we may discover that we must go much further than Moore's proposal and relate mathematics instruction to all the science taught in high schools. The time has come to find out.

THERE is no existing machinery and there are no funds available for the type of study proposed here. Our professional organizations are not in a position to undertake the thorough investigations that are here suggested. It is to be hoped that the National Science Foundation, if and when created, will make this investigation one of its first projects, for certainly neither science nor mathematics teachers have ever made a serious effort to meet the challenge of the vision expressed by Moore nearly a half century ago.

4. Quoted from an address made in 1902 by Professor Eliakim H. Moore. Science N. S. March 13, 1903, pp. 401-16.

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Continued from Page 74

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SCIENCE TEACHING TODAY

Continued from Page 62

students with a high degree of scientific talent as a substantial step toward a general program to encourage able youth *in all fields* to become educated to the limits of their ability.

(6) We must establish an adequate number of post-doctoral fellowships to supplement fellowship grants by Universities and other organizations. This will provide:

a. A way to utilize the ability of young scientists who have just finished the Ph.D. and are eager to continue with basic research problems.

b. Older scientists, who frequently have to many routine duties in their regular jobs the opportunity to refresh their scientific spirit, and to study new methods of science education and research in new enviroments.

Long Range Program. Comprehensive investigations should be undertaken to:

1. determine the concepts and principles of science and mathematics essential to an adequate program of General Education.
2. secure experimental data to aid tea-

Continued on Page 96

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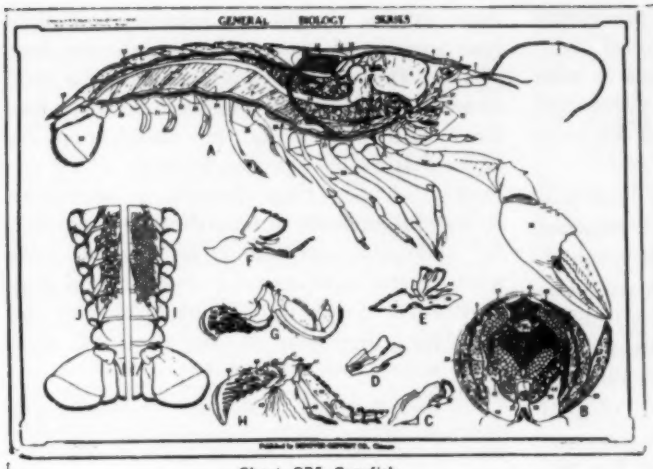

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SCIENCE PROJECTS

Continued from Page 71

make a career of physics or mathematics this was a useful study in furthering his knowledge in these fields. He found the curve was not alone for beauty but necessary in order to tune the strings to produce the musical scale. After developing a curve mathematically and theoretically for perfect production of sound he found with amazement that it was the same as the standard and that "without knowing the required mathematics, or performing any calculations, the master craftsmen of the Renaissance period were able to construct, by intuition or by trial and error, instruments which satisfied the requirements in every way."

Scientists Keep Records

FOR FOUR years George Edgar Koehler, seventeen, of West High School, Madison, Wisconsin, has kept methodical records of the bird life in an eighty-acre wooded tract, a Madison cemetery. On a warm day in June he saw 683 individual birds—his record; the lowest was after a two-day blizzard when the only birds he could find in the snowy bleakness were two bluejays.

George keeps records of bird species and number of individuals, makes notes of all weather conditions, and correlates his bird counts with environmental factors. He also studies nests, and has found 466 nests representing twenty-one species during the four years of his study. Much of his work has already been published in ornithological journals. He plans to become a research biologist.

Scientists Are Resourceful

George Camamis,* seventeen, of New Brunswick (N. J.) High School, lives near the ocean, so he chose to investigate sea water. He used a method of his own devising in a successful attempt to extract gold from it. He made several gallons of sea water highly acid with hydrochloric acid and added one gram of barium chloride. The precipitate was allowed to settle for several days, then he decanted the clear water off. After neutralizing this water with sodium hydroxide and after adding a very small quantity of barium

chloride he obtained another precipitate which he allowed to settle for several days. He collected the precipitate, washed it with distilled water, and dried it. This precipitate was supposed to contain the gold in the form of barium aurate.

After drying the precipitate, he heated it with a blowpipe on a charcoal block together with lead and borax. A glass bead resulted, in which a minute quantity of free gold was expected to be present. Crushing the bead to a fine powder, he added mercury to pick up the gold and to form an amalgam. When he evaporated the mercury; a thin film of gold was left behind in the crucible. He was not much richer except in experience for his career as a research chemist.

Kurt Kohn, seventeen, of the Bronx (N. Y.) High School of Science wants to do research in physical science for his life work. He has been carrying on some research with ants. He investigated the ability of ants to identify their friends. For this he built an observation nest penning the insects between two eight-inch squares of glass, in an eighth-inch layer of soil. The whole nest was placed on a block of wood, with a water moat around it to keep the ants from straying. He found some evidence that the recognition-scent by which ants readily identify their friends is hereditary. By careful methods of identification—painting the abdomens—he found, for instance, that when several ants reared from the pupal stage by stranger nurses were returned to their parent colony they were at once accepted, while their nurses were thrown out.

The encouragement of young scientists is the year round purpose of Science Clubs of America. There are now about fifteen thousand affiliated clubs throughout the world with about one-third of a million members. There is no fee for affiliation. The national headquarters furnishes program ideas and helps. It coordinates efforts of many state, district, and local organizations of scientists and educators who are helping youthful scientists.

The Eighth Science Talent Search is now on. It will culminate in December, 1948. The Search is sponsored annually by Science Clubs of America with funds provided by the Westinghouse Educational Foundation. It is open to seniors in private, parochial, and public schools throughout continental United States.

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BOOK SHELF

CHEMISTRY IN ACTION. George M. Rawlins, Austin Peay State College, Clarksville, Tennessee, and Alden H. Stuble, Western High School, Washington, D. C. D. C. Heath and Company, Boston, 1948. 568 pp., 16x25.5 cm. 426 Illus. $3.00.

In *Chemistry in Action* the authors have kept two major objectives in mind: "(1) to help you understand and appreciate the role of chemistry in your lives and (2) to help you learn to reason scientifically." As a result the teacher will find the book very useful in attaining these most desirable outcomes of learning.

In organization the book is quite similar to most chemistry texts. In developing the units it stresses problem solving less and organic compounds more than t : usual text.

In material included, *Chemistry in Action* is up-to-date, including such modern chemical developments as atomic energy, new methods for controlling insect pests, synthetic rubber, and plastics.

The book is pleasing in format, has a two-column page, and is well illustrated. It should prove to be a very teachable text.

HEAT. Archie G. Worthing and David Halliday, University of Pittsburgh. John Wiley and Sons, New York, 1948. 522 pp. 14½x23 cm. $6.00.

In this text the laws and principles associated with the phenomena of heat as seen in nature and industry are presented with clarity and accuracy of statement. Particularly outstanding is the use of the experimental approach referring to the investigator, or author that has done exceptionally good work in the area reported.

The text includes material appropriate for a first undergraduate course following an introductory college course in physics and is also suited to the later junior-senior or early undergraduate level.

Elementary thermodynamics and change of phase are included as are also convection and radiant energy.

The book is replete with graphs and diagrams to make the thought clear. There is an abundance of problems at the end of each unit.

DAVISON'S MAMMALIAN ANATOMY. (Seventh edition). Revised by Frank A. Stromstein, University of Iowa. The Blakiston Company, Philadelphia, 1947. 394 pp. 15x23 cm. 187 illus.

In its seventh (revised) edition *Mammalian Anatomy* (with special reference to the cat) reflects to some degree the trend of anatomists to give more attention to the functions of morphologic structures and to their adaptational histories. However, most of hte space is given to the location and description of the various organs and parts of the body.

The book is written in the language of the anatomist and is exact. It is most suitable as a college text and high school reference. The numerous diagrams add to the clarity of the text. A glossary includes the less common technical terms.

GENETICS IS EASY. Philip Goldstein, Bronx High School of Science, New York. Garlan Publications, 77 River Street, Hoboken, N. J., 1947. 72 pp., illus.

For a simple and clear presentation of genetics the student and teacher will want to read *Genetics Is Easy* by Philip Goldstein. Beginning with questions that naturally confront the learner a background of understanding is built up based on Mendel's laws. This is followed by studies of specific phases of the problem. The book will answer such puzzling questions as how can a trait skip a generation, how are human blood types inherited, and why cannot a male bleeder pass the defect on to his son.

Attention is given mathematical computation and the modern problem of hybrids. Many diagrami help in making the thought clear. The book is particularly suited as a reference and for supplementary study in biology.

WORKBOOK IN MECHANICAL DRAWING. S. L. Coover, Director of Industrial Arts Department, State Tecahers College, Indiana, Pennsylvania. McGraw-Hill Book Company, New York City, 1947. ,201 pp., 19x28 cm. Illus. $1.48.

This workbook presents a first course in mechanical drawing designed to meet the needs and interests of junior and senior high school students. Instead of starting with long problems of the engineering-drawing type, short interesting problems are used that can be completed in two or three days. Interest is easy to maintain for the shorter completion period and students can more readily see the progress they are making. Fundamentals of blueprint reading are presented through such drawings as a softball diamond, a tennis court, and an airport. Sketching practice is given with ample opportunity to learn the use of the tools needed. A unit on home planning acquaints the student with the symbols and principles used in architectural drawing. Projects include fruit knives, motors, wood mitre boxes, mallets, etc., that are of special interest to the student of secondary school age, whether he has his own work shop or not. Individual differences can be cared for by supplementary assignments.

HOW MAN DISCOVERED HIS BODY. Sarah R. Riedman. Illustrated by Frances Wells. International Publishers, 381 Fourth Ave., New York City, 1947. 128 pp. Illus. $2.25.

Some of the great adventures of man are concerned with the discovery of the parts of the body and their functions. When Dr. William Harvey discovered the circulation of the blood some three hundred years ago, it was not only a thrilling experience, but a great step forward in human progress.

The reader will find it difficult to lay aside *How Man Discovered His Body* until he has followed through to the end in adventures with Harvey, Hippocrates, Vesalius, Lavoisier, Bernard, Cannon and other outstanding investigators. One will not only learn how parts of the body were discovered but also much about them. Certainly the learning will be most enjoyable.

Tower, Harold E. and Gardner, Harry H., STRIP CROPPING FOR CONSERVATION AND PRODUCTION. Farmers' Bulletin No. 1981, USDA. 46 pages, 1946. Superintendent of Documents, Washington 25, D. C., 10 cents.

This bulletin treats the kinds and use of strip cropping, factors to be considered in the selection of type, the layout and development of contours together with crops to be employed in various regions of the United States, and the values of strip cropping in conservation and production. Detailed suggestions for crop rotation are included. A very useful publication for illustrating an important phase of conservation to elementary and secondary school pupils.

THE RADIO AMATEUR'S HANDBOOK. (24th edition). The American Radio Relay League, Inc., West Hartford, Conn., 1947. 469 pp. and 152 pp. 16x24 cm. illus. $1.25.

This 1947 edition of The Radio Amateur's Handbook, like its predecessors, will find ready acceptance among the radio interested people from amateur to engineer and serviceman.

It retains the sections of the preceding edition dealing with principles and design, but presents the building of new equipment in terms of the best current materials as tested by actual trial. As in former editions the popular "how to do it" plan of presentation is followed.

The book serves to keep one abreast of what is new in the field as well as providing an excellent working text for individual and club use.

FUNDAMENTALS OF CHEMISTRY. (Sixth edition). L. Jean Bogert. W. B. Saunders Co., Philadelphia, 1946. 571 pp. 13x19½cm. 155 illus. $3.00.

This latest revision brings the book up-to-date in terms of modern applications and in keeping with the general trend in high school chemistry texts. The material on oxidation and reduction has been expanded and the chapter on ionization has been largely rewritten. The unit dealing with vitamins is particularly outstanding and should be impressive to the student as well as give him a sound point of view.

The book is clearly and interestingly written and is well illustrated. A laboratory manual to accompany the text is also available.

SPROUTING YOUR WINGS. Bruce H. Guild, Iron Mountain High School. McGraw-Hill Book Co., New York, 1947. 114 pp., 7½x10 inches, paper cover. $1.32.

This is a book on aviation, written in interesting conversational language, for the junior or senior high school student. It is profusely illustrated with photographs and artist's pictures and drawings. The appendix includes questions for discussion, as well as project suggestions relating to each chapter. The book was prepared for the Committee on Experimental Units of the North Central Association of Colleges and Secondary Schools. It is a definite contribution to secondary school science material.

COMPARATIVE PHYSIOLOGY. Bradley T. Scheer, Ph. D., Assistant Professor of Biochemistry and Lecturer in Zoology, University of Southern California. John Wiley and Sons, Inc., New York. Chapman and Hall, Ltd., London, 1948. 563 pp., 14.5x22 cm. Illus. $6.00.

This book is designed as a text suitable for an advanced university course in comparative physiology. The author has consulted more than one thousand original papers, and the experimental results have been organized into a series of sketches on the physiology of each of the major animal phyla. Instead of the usual treatment by functional units the phylogenetic treatment is used.

The first chapter provides an introduction to some of the fundamental physiological concepts. Each chapter discusses nutrition, feeding, digestion, circulation, respiration, metabolism, excretion, regulation of the internal environment, and the neuromuscular system, in that order. In the summary concluding each chapter, particular attention is paid to important ecological and evolutionary developments within the groups considered. The last chapters, dealing with the vertebrates, provide a brief general review of the basic principles and variations noted earlier in other phyla. They also present a brief summary of the physiology of the vertebrates.

LABORATORY CHEMISTRY. William E. Price, Clifford J. Scott High School, East Orange, New Jersey. World Book Company, Yonkers-on-Hudson, New York, 1947. 133 pp. 19x26 cm. illus. $.92.

This laboratory manual for high school chemistry provides forty-eight experiments that are easy to follow covering the usual course and bringing out the principles and facts that need to be learned through experiences. The order of the experiments can be varied to suit the needs of the teacher, as each experiment is on a separate sheet.

In addition to the more usual experiments others are included of a more practical nature, such as *Stain Removal*, *Testing a Dentifrice*, and *Leavening Power of Baking Powders*. Also included are fourteen project experiments that can be used as extra work or to increase interest.

For the areas that do not lend themselves to experiment there are exercises to supplement the material studied. Problem drill work is also included.

THE NAMING OF THE TELESCOPE. Edward Rosen, College of the City of New York. 1947. 110 pp. Henry Schuman, Inc., New York. $2.50.

Though Galileo's failure to suggest a distinctive name for his instrument is well known, it remained for Dr. Rosen to provide the first thoroughgoing solution of the problem. Dr. Harlow Shapley, in his Forward to the book, says it is "an entertaining glimpse of science and society in the days of the scientific revolution three and a half centuries ago . . . In its erudite way, the book is a delectible thriller. It is good sleuthing . . ." J. S.

CHEMISTRY. Second Edition. John C. Hogg, Phillips Exeter Academy, Exeter, N. H.; Otis E. Alley, Winchester High School, Massachusetts; and Charles L. Bickel, Phillips Exeter Academy. D. Van Nostrand Company, Inc., New York, 1948. 533 pp., 15x23 cm. Illus.

The authors of *Chemistry* believe the industrial phase of this field is not only currently important to everyone, but is rapidly growing more so. Consequently in this second edition, as in the first, the chemistry of industry is given much attention.

The book breaks somewhat with the traditional organization of high school texts in this field, placing carbon and its compounds quite early in treatment. This permits a study of fuels and energy at a time when people are particularly concerned with the heating of homes. Theoretical chemistry and the more difficult problem work is sandwiched with descriptive material, serving to give some relief to students after a short period of strenuous work. More difficult items are presented in smaller print and may be omitted at the option of the teacher.

Included in this second edition is a revised and enlarged section dealing with atomic energy. Also included are the new elements, new drugs and detergents.

MODERN POLISHES AND SPECIALTIES. W. D. John, Consultant Industrial Chemist. Chemical Publishing Company, Inc., Brooklyn, 1947. 313 pp., 13x21.5 cm. $7.50.

Modern Polishes and Specialties is a very practical treatise of the problems involved in formulating polishes and many related specialty products. It also provides many basic formulas that may be used as a starting point in the making of products in this field. Highly technical and theoretical discussions have been omitted, making the book very usable for the average non-technical worker as well as the trained scientist.

HOMEMADE EQUIPMENT

Continued from Page 69

Then use the saw to shorten it by small amounts until it is in tune with a G on the piano. A rasp or wood file is helpful in taking off the last fraction of an inch to bring it into tune. Next, saw a length for the high note, G, one octave higher. Because this length must vibrate twice as fast, it must be one half as long. Cut it a little oversize and bring it into exact tune using the rasp. The other two, C and E, are between the two just described. Cut lengths you estimate are full long and, with the saw and rasp, bring them into tune with the piano. To mount each wooden bar, bore 1/8" holes 1/4 of the bar's length from each end of the bar. Use a piece of wood 6" x 8" for the base and nail the bars very loosely to the base. Have lengths of felt or clothesline between the bars and base at the nails. Here again the number of notes that can be included in the xylophone is limited only by the imagination or materials at hand, and perhaps by the number of keys on the piano. Similar, beautifully toned instruments can be made using brass or steel bar stock, or brass tube, or gas pipe for the bars.

If interest becomes high in the building of these musical instruments, see what the class can do with these suggestions: (1) A one (or more) string violin or ukelele can be made using a cigar box for the sound box and old violin or ukelele strings. (2) Whistles can be made from sections of bamboo fishing rod. Use modeling clay to partly close the mouthpiece end. Four whistles can be tuned and bound together to make a "Pan-pipe" for bugle calls. Other variations are the "trombone flute" with a plunger to vary the length of the air column and the conventional flute with holes at various distances along the air column.

A demonstration to show the conduction of sound through solids requires only a watch and a long stick, pipe or table. It is always surprising to press an ear against the stick, pipe or table and clearly hear the ticking of the watch pressed against the other end, five or ten feet away.

The best version of the mechanical telephone is made using two round oatmeal boxes and a length of tough string or thread. Button

(Concluded in October Issue)

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In this group are found examination and purification of water; testing of lubricating oil, paint, baking powder, wool, silk, cotton, rayon and linen; electroplating; metal working; hydrogenation of oil; getting sugar from corn; tanning leather and fur; making bakelite; cold cream and vanishing cream, baking powder, mirrors, ink, polish, and plastic wood.

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Available in October, 1948

General Science Projects

(Published, October, 1942)

Among the projects are the following: amateur range finding, how to navigate by sun and stars, weighing without scales, making and using solutions, seven ways to start a fire, seven ways to put out a fire, chemical indicators, a rock mineral collection, a pin hole camera, printing pictures, learning to be a radio amateur, a pendulum project, testing foods at home, digesting food with saliva, canning food, how good are the arches in your feet, surveying the teeth, and clay modeling and casting.

34 Projects, 95 pages, mimeograph $1.25

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News and Announcements

Nine films in a series of 16 mm. sound films, designed specifically to assist teachers in getting across to students basic concepts regarding the American way of life, are now available for purchase by schools. This series, appropriately called *Our Land and People*, has been produced by Films Incorporated, 330 West 42nd Street, New York, N. Y., in collaboration with Twentieth Century Fox Film Corporation.

Titles of some of these films which should be of interest to science teachers are: *The Story of Transportation, Conservation Road, The Story of Our Natural Resources, Inventions and People, The Story of Communication, and Light and Power.*

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The General Electric *News Digest* is published bi-monthly to give interested persons news of the activities and developments within the company. Address The Editor, *News Digest*, General Electric Company, Schenectady 5, New York.

Illinois Chemistry Teachers Meet

THE ILLINOIS Association of Chemistry Teachers will meet May 1, in Ottawa. Field trips to the Ottawa Marble Plant and to the Alpha Cement Plant of LaSalle will be featured during the morning. After a luncheon and business meeting in the Starved Rock Park Lodge, the program will be presented in the Ottawa Township High School.

Recreation Conference in Massachusetts

The Twelfth Annual Recreation Conference was held April 8-10 at the University of Massachusetts, for community leaders of the state and those interested in this field. A very elaborate program was presented. Dr. Lawrence V. Loy of the university served as chairman.

Write to United Airlines for a *Directory of Free and Inexpensive Aviation Education Materials*. The address is 5959 S. Cicero Avenue, Chicago 38.

For a new catalog of film slides write to Visual Research Company, 30 North Dearborn Street, Chicago 2.

SCIENCE TEACHING TODAY

Continued from Page 90

chers in planning an effective grade and age placement for the teaching of these concepts.

3. A detailed study of methods of early identification and guidance of science talent at all school levels should be undertaken.

These recommendations are not very radical, nor is it particularly expensive to carry them out. They are the bare minimum to assure that we will have enough well-trained teachers for our schools and be able to train an adequate number of scientists for our country.

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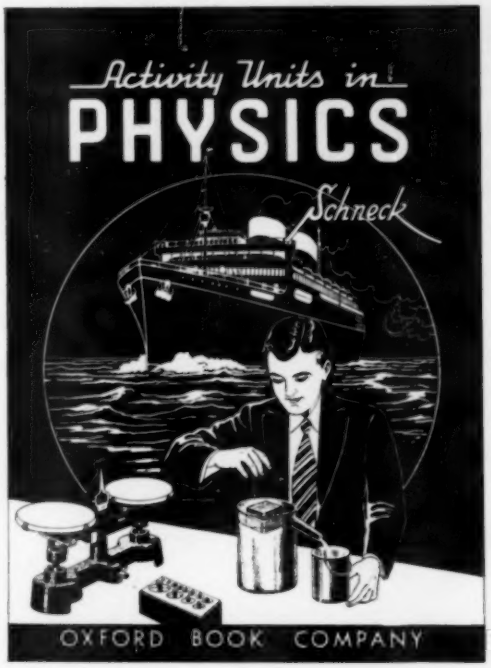

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